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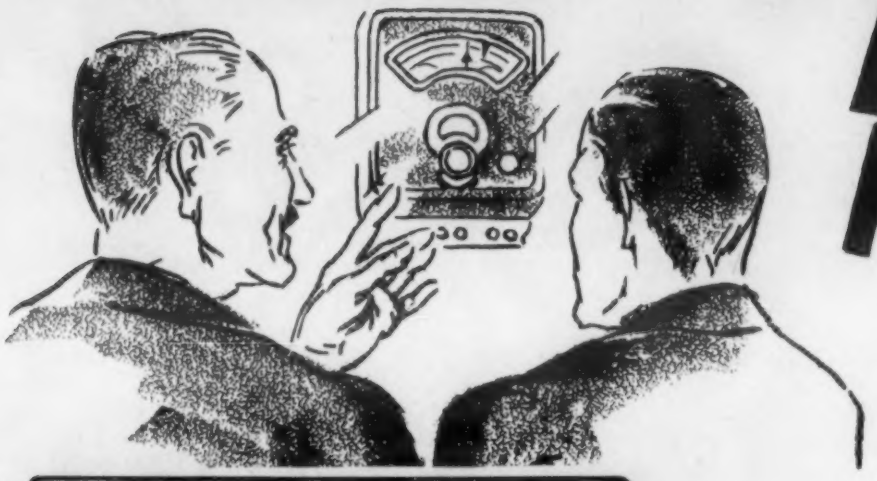

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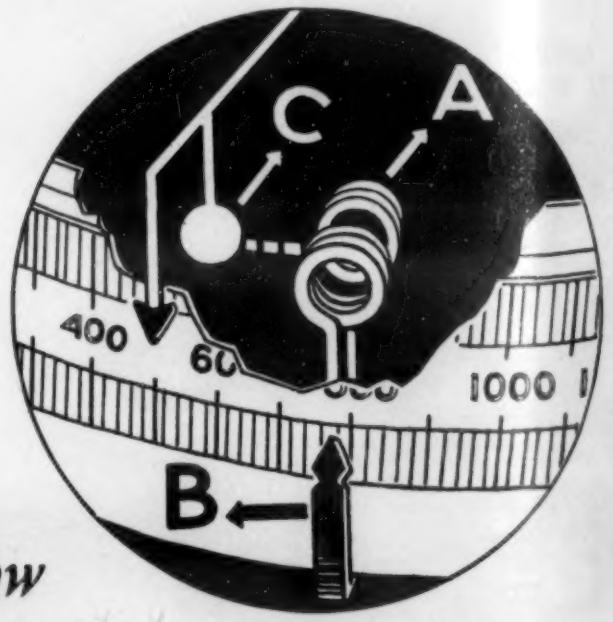

Here's How

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HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Magic

According to Kravatzov and Sapiro (page MA 439 L 2) the addition of 0.90 per cent silicon as a final furnace addition to a basic heat does not hinder dephosphorization.—C.H.H.

When Blow Holes in Ingots Weld Completely

Kohira (page MA 444 L 4) finds that blow holes in a rimmed ingot weld completely only when the ingot is given at least 90 per cent reduction.—H.W.G.

Casting Rod Bearings Under Pressure

In a German government railway shop, rod bearings, says Martin (page MA 444 R 10) are cast under pressure and finished by rolling without machining. The babbitt is only 1 mm. thick, i.e., only 10 per cent of the thickness previously used.—H.W.G.

Precipitation vs. Supersaturation Hardening

By means of X-ray studies Wassermann and Weerts (page MA 447 L 7) throw more light on the hardening of Al-Cu alloys and Benedicks (page MA 447 L 8) elaborates on a theory of hardening due to supersaturation and "crystallization centers."—O.E.H.

Burglar's Union—Take Notice

Banks (page MA 450 R 2) reports that by using ether with an oxy-acetylene torch one can easily cut through steel a yard thick. If the research staff of the burglars' union read our abstracts we may expect to hear of the hold-up of a hospital for its ether prior to attack upon a bank vault.—H.W.G.

Arc and Induction Furnace Combined!

Nathusius (page MA 450 R 3) thinks that a combination of arc and induction heating may be the future steel melting furnace. How about the first cost of such an installation with the two systems on the same furnace.—H.W.G.

Where Steel Weighs Less Than Wood

The 165 ft. 7 in. welded steel mast of the Boston sloop "Yankee" (page MA 452 L 4) weighs only 5,700 lb. as compared with 6,200 lb. for the former wooden mast used in the 1934 America's cup trials. Besides saving 500 lb. in weight, the welded steel mast makes it possible for the "Yankee" to save 320 sq. ft. of windage. This is equivalent to the sail area of a 30-m² or 42-ft. racing sloop.

Stepping this mast was a delicate job and required over 50 men and a floating derrick. A 50-ft. timber lashed to the mast relieved the strain placed on it during handling. The derrick then picked up the mast and swung it into place. Capstan bars were used to twist it into proper position.

The "Yankee's" steel mast, fabricated entirely from arc welded nickel steel is the first of its kind ever made in America. It contains 450 ft. of welded seams. A special electrode which provides welds with 85,000 to 100,000 lbs./in.² tensile strength in high-tensile steels was used.

In the test of the "Yankee's" new racing rig in a sail-stretching run in the face of a spanking 12-knot southeast blow, the welded steel mast showed no signs of whipping.—E.V.D.

The Bad Actor in Pickling Steel—H_2 or H_2S?

Bablik (page MA 453 L 6) says that presence of H_2S increases penetration of H_2 into steel in pickling. H_2S is the bad actor. Vollbrecht and Dittrick (page MA 462 R 2) find that around 200 to 300 deg. C. and 200 atmospheres H_2 is worse than $H_2 + H_2S$ and that it is H_2 that is the bad actor. How distressing to one who would like to argue by analogy and anticipate one observation from the other.—H.W.G.

Lead Coating by Wiping

For many chemical purposés a lead-coating is the only solution of the problem. Lead coatings, unless applied as a lining formed out of sheet lead, are notably porous. A method for producing coatings by "wiping" the surface with molten lead appears very promising. It is essential that the surface of the metal to be coated be given a preliminary tinning in order to obtain good adherence of the lead. Coats as thick as 10 mm. can be applied by the process (page MA 455 L 2). Evidently considerable skill obtained only by experience is required.—H.S.R.

Simple Method for Producing a Permanent Blackening Finish On Iron

A method for coloring iron and steel utensils black, brown and other colors by an inexpensive oxidation process would seem to have numerous applications. The well-known process of temper coloring, either by heat alone or by heating in a fused salt bath, is relatively expensive for the small user and in many cases is entirely inapplicable. A strongly alkaline hot solution to which certain oxidizing substances are added seems to offer many advantages for this purpose (page MA 455 L 7).—H.S.R.

Polishing Copper Rapidly

Speed and economy are claimed by Jacquet (page MA 459 L 4) for an electrolytic method which follows a rough emery-paper polish. After the juice has done its stuff, the specimen is ready for the metallographic etch.—J.S.M.

Accurate — Economic — Intellectual

What more could a metallurgist want? By using a small surgical saw of the type employed in operating on the human skull, Chevenard (page MA 456 L 9) inaugurates a new method in the microscopic examination of welds. Numerous tiny specimens for complete microscopic survey (accurate). Non-destructive examination of welds (economic). Surgical brain-saw for micro-specimen preparation (intellectual).—W.A.T.

More Tales of Electron Diffraction

Several months ago this page reported further merriment for Beilby's ghost. Thomson (page MA 459 L 2) provides still more, for three experiments by the method of electron diffraction confirmed the amorphous layer on polished metal surfaces. Other matters of interest are the constitution of rust, and of oxide films on silver and copper. Further, there is information on the orientation—or lack of it—of crystallites in sputtered films.—J.S.M.

Another Possibility for Surface Treatment

Ordinary cast iron is not suitable for apparatus used in hydration plants as stated by W. Baukloh (page MA 460 R 2). It is suspectible to deterioration by hydrogen, the effect increasing as the carbon content increases. However, Baukloh's work suggests that research on the surface treatment of cast iron for resisting hydrogen penetration would be a more lucrative field from the economic standpoint than the development of alloys.—V.V.K.

Ductility of Rails Increases With Time

According to Körber and Mehovar (page MA 460 R 5) internal stresses in rails are high enough so that the ductility increases measurably with the passage of time, as these stresses become equalized. This is of interest in relation to the problem of shatter cracks and their avoidance by slow cooling.—H.W.G.

Sulphide Inclusions Deformable

Schnell and Scheil (page MA 460 R 7) say that sulphide inclusions are as deformable as steel itself even at minus 80 deg. C.—H.W.G.

Who Cares?!

Zamoruev (page MA 460 R 8) finds that 1 per cent Cu steel is 15 times as stable in 5 per cent H_2SO_4 as copper-free steel. Who cares? Is anybody going to make pickling tanks out of either steel?—H.W.G.

More on Food Products

Increased interest in the effect of metals on food products is evident in the increased number of recent articles. The effect of various metals on milk is given by Whitfield, Davis and Downs (page MA 462 R 4). Compare with (page MA 415 L 5 and 6, Aug.) for other food products.—V.V.K.

Higher Prices for Tin Predicted

According to "Tin" the organ of one tin producer, not of the allied group of producers, there is a great probability that the price of tin may rise in the future to 2 or 3 times the present one (page MA 466 L 9). With tin at $1.50 per lb. there certainly would be a whole flock of substitutes in many of the uses of tin. We'll bet that the tin magnates would make far less profit on the tonnage that would be used at such a price than they do now.—H.W.G.

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(This Series was Started in the July Issue)

JAMES T. MacKENZIE is chief chemist and metallurgist of the American Cast Iron Pipe Co., Birmingham, Ala. He received his degree of B. S. in chemical engineering as well as his M.A. degree from the University of the South, Sewanee. In June, 1930, the university gave him the honorary degree of D.Sc. In 1933 the university also bestowed on him the honorary Phi Beta Kappa.

He has spent all of his commercial career with the American Cast Iron Pipe Co., as analyst from 1912 to 1914, in research from 1914 to 1915. He has occupied his present position since 1915.

Among Dr. MacKenzie's many contributions to technical literature may be mentioned: "The Standard Test Bar for Cast Iron Pipe," "The Influence of Phosphorus on Cast Iron," A.S.T.M. *Proceedings,* 1924 and 1927 respectively; "The Influence of Phosphorus on the Strength Properties of Cast Iron Pipe," *Journal* of the A.W.W.A., June, 1928; "The Properties of Coke Affecting the Cupola Melting of Steel," American Exchange paper, Institute of British Foundrymen, *Proceedings,* 1927; "Carbon and Sulphur in the Cupola—Some Properties of Coke," *Transactions,* A.F.A., 1930.

JAMES T. MACKENZIE

The following societies list Dr. MacKenzie as a member: The A.C.S., A.S.T.M., The Electrochemical Society, Amer. Ceramic Soc., A.I.M.M.E., Iron and Steel Institute (British), and the Assn. Technique de Fonderie de France. His chief recreations are bridge and music; he plays the bassoon and the pipe organ.

CHARLES A. McCUNE is director and secretary of the Magnaflux Corp., New York. His education was received at Cooper Union, New York. After being associated with the Safety Car Heating & Lighting Co. as chief draftsman, he became assistant engineer in 1904 and later chief engineer of the Commercial Acetylene Co., retaining this position until 1916 when he became sales engineer of the Page Steel & Wire Co. In 1924 he was made director of research of the American Chain Co., where he remained for 6 years. He resigned to become director of research of the Welding Engineering & Research Corp. When this company dissolved, he assumed his present connection.

CHARLES A. McCUNE

Mr. McCune is characterized by an authority as one of the "pioneers of welding." He is one of the founders of the American Welding Society and since 1919 has served as chairman of one of its important committees. He became president of the society in 1922 and has been its treasurer since 1923. He has also been president of the International Acetylene Association. He is a member of the A.S.M.E., the A.S.T.M., the A.W.S. and the advisory board of the National Bureau of Standards. He was awarded the Samuel Wylie Miller Memorial Medal last month.

From the pen of Mr. McCune have come numerous papers on acetylene and its uses, the metallurgy of welding rods, the manufacture of iron and steel and so on.

ROBERT F. MEHL is director of the metals research laboratory and professor of metallurgy, Carnegie Institute of Technology, Pittsburgh. He received his B.S. degree from Franklin and Marshall College in 1919. After attending the graduate college of Princeton from 1920 to 1923, he obtained his Ph. D. degree in 1923. He was Proctor Fellow in his last year there. After acting as professor of chemistry at Juniata College from 1923 to 1925, he became National Research Fellow at Harvard from 1925 to 1927. Dr. Mehl was superintendent of the division of physical metallurgy at the Naval Research Laboratory from 1927 to 1931 and assistant director, research laboratory, American Rolling Mill Co., Middletown, Ohio, from 1931 to 1932, after which he assumed his present position.

ROBERT F. MEHL

The following may be mentioned as some of the outstanding work of Dr. Mehl: Research on compressibility; interatomic forces and crystal structure at Harvard; many metallurgical problems at Naval Research Laboratory; research on low-carbon and electrical steels at Middletown; at present in a laboratory of 15 members scientifically studying metals and alloys (50 publications from this laboratory to date with about 15 to appear this year by the staff); author or joint author of 40 technical papers.

The John Scott Medal and Award was given to Dr. Mehl by the City of Philadelphia in 1934 for the development of Gamma ray radiography. He received in 1934 the Institute of Metals Division Award of the A.I.M.M.E. for the best paper (Studies Upon the Widmanstätten Structure.) He is a member of numerous technical societies.

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EDITORIAL COMMENT

Details

THE ramifications and details that arise in the development of any new metallurgical product or method sometimes seem appalling. We start out with some innocent thing like 18:8, apparently simplicity itself because it is austenitic and so can't be heat-treated in the usual way, and apparently resistant to corrosion of many types. As we go along it, we bump into carbide separation, embrittlement, corrosion by pitting where it was not expected, and what not, and we have to go into the situation with a fine tooth comb to eradicate the bugs. Many man-years have to be spent before the possibilities and limitations are fully explored. A mass of specialized literature, and a lot of practical experience in the minds and hands of skilled workmen, grow up.

In such a case the whole thing looks bafflingly complex for years until finally the correct theories are evolved, apparent contradictions are reconciled, and it again becomes simple and understandable.

Again, there is the type of thing that looks weird or highbrow at the start and quite beyond general understanding and extended use. The high-frequency furnace, in the line of equipment, and the X-ray diffraction mode of getting information in the laboratory, are cases in point. These looked so strange and complicated, involving so much higher mathematics for their scientific development, that only a few could, at their inception, visualize the widespread use that would come to them.

We are prone to be dismayed by the vast amount of detail needed before a metallurgical process or product is perfected when we have to deal with it ourselves, because we assume that things in general spring up full grown, especially simple things. We can realize that a lot had to be done to bring the mechanical end of radio to its present perfection, (we avoid any comment on the stuff that is brought to us over the radio), or to develop the airplane, and we can accept the fact that there must be specialists with years of painstaking detail work behind them.

But there has really been specialization in every field while the things we take for granted were being developed. As one of the speakers remarked at the A. S. T. M. meeting in June, the housewife classifies potatoes as new or old, or as those for baking or for boiling, while there are in the potato trade actually many fine distinctions, technical terms, etc., known only to the initiated.

The color printing on the cover of a modern magazine involves a lot of attention to inks, humidity control, and this and that, to accomplish the exact registry. A fountain pen seems like a simple thing, but it is a result of long struggles with problems of many types. When we look at a figured textile and think how helpless any but experts would be in trying to handle its dyeing and weaving, or if we consider how difficult we would find it to make a watch or even a pair of shoes of decent quality at a decent price if we were given unlimited money with which we could buy everything but experienced and specialized knowledge, our own problems, where we do have at least a modicum of the special knowledge and know where to get help from the literature and from experts, may not seem so complex after all.—H. W. G.

Specifications for Electroplated Coatings

THE recent adoption by the American Society for Testing Materials, the American Electroplaters' Society, and the Master Electroplaters' Institute of specifications for electroplated coatings on steel, marks a milestone in the electroplating industry. Although Government departments and large manufacturers, especially in the automobile industry, have in recent years employed specifications for electroplated coatings this is the first time that national organizations have adopted such standards. A discussion of their possible value and limitations may foster their intelligent use.

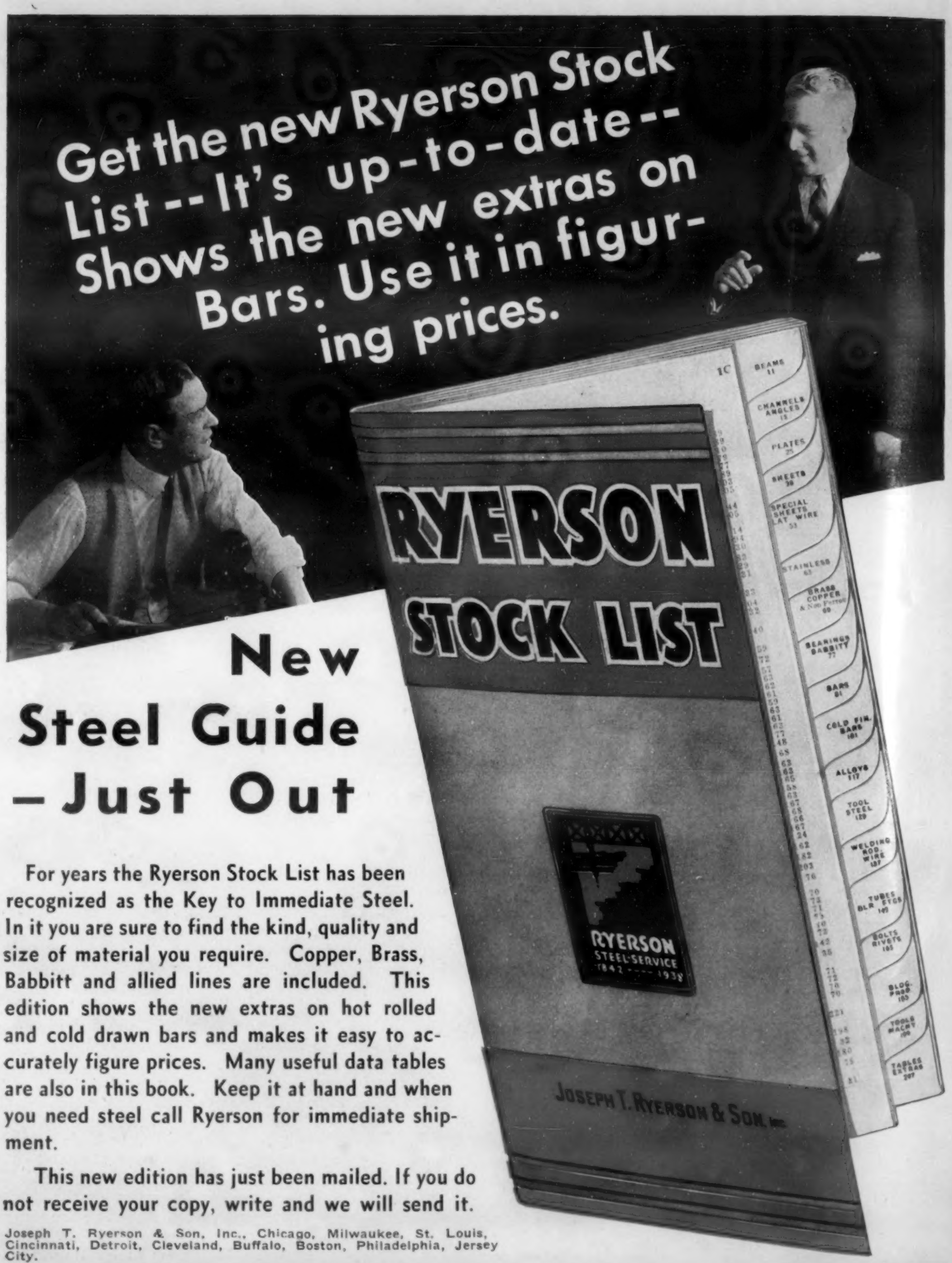
The essential requirements are very simple, namely (a) for nickel and chromium finishes: (1) a minimum thickness of nickel (or of nickel plus copper) on significant surfaces, (2) an average thickness of chromium, and (3) a definite resistance to salt spray; and (b) for zinc or cadmium coatings: only a minimum thickness.

The word "tentative" is very wisely associated with these standards. In spite of the fact that they rest upon the results of extended cooperative researches and upon the experience of manufacturers, it remains to be seen whether they can be advantageously applied to a large proportion of the very diverse applications of plating on steel. In order to avoid complexity and confusion, only two "standard" grades of each kind of plating were recognized, namely for "general" use and for "mild" conditions. No effort was made to include specifications for coatings to be used under very severe conditions or for the plating of low-priced, short-lived articles. But there are obviously many more than two types of service for plated articles, and even a given article may, according to circumstances, be subjected to a wide variety of conditions.

Sound practice in any industry demands that an article of good quality should withstand reasonably well the most severe conditions to which it will probably be subjected. Each manufacturer and large consumer must therefore decide what kind and grade of plating will best meet the probable requirements for a given article. In making such a selection, especially at first, it is to be hoped that in doubtful cases the higher grade of plating will be adopted. The cost of applying a plated coating is by no means proportional to its thickness, as the polishing, cleaning, pickling, and buffing (which are practically independent of the thickness) make up a large part of the cost of the entire finishing process. The use of very thin, inadequate coatings has often cast discredit on the plating industry and has thus harmed the reputable manufacturer of plated goods.

One striking feature of the new standards is their requirement in most cases of a minimum rather than

(Continued on page 306)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Continuous Pouring of Ford Cylinder Blocks

By EDWIN F. CONE

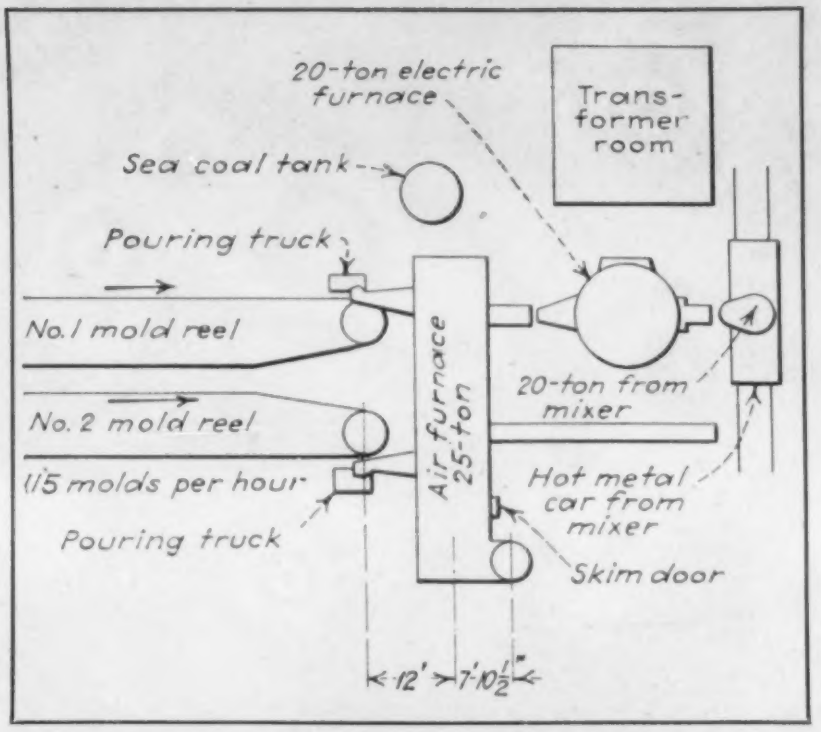

Fig. 1.—General Plan of the Equipment for the Continuous Pouring of Ford Cylinder Blocks. The hot iron comes from a mixer in a hot ladle car to the 20-ton electric furnace. From there it flows by gravity to the air furnace and from the air furnace to the molds.

POURING CAST IRON in a continuous stream from furnaces to molds is the recent achievement of a large motor car manufacturer. Hour after hour molten metal flows, without any interruption and carefully regulated as to composition and temperature, into molds as they travel continuously on conveyors. The operation is an impressive one and, as at present carried out, it is believed it does not have its counterpart anywhere else. It is the object of this article to tell the story of the evolution of this process.

In operations of the magnitude of those carried on by any large motor company, the production, regulation and handling of large volumes of metal combine to form a difficult problem. In the manufacture, for example, of cylinder blocks of cast iron, where as many as 6,000 to 6,500 a day must be turned out, it is at once realized that the solution of this problem is not an easy one. But the Ford Motor Co. at its Rouge Plant in Dearborn, Mich., has recently made radical and novel changes in its foundry operations which solve just such a problem.

When operating at capacity, there are required about 850 tons of molten cast iron per day of 16 hr. to produce the required number of cylinder blocks, while the total metal for foundry is 2,200 tons. To obtain this large quantity of metal the Ford engineers and metallurgists have perfected a practice which involves several steps.

The Iron Assembled in a Mixer

The first step in the assembling of the metal is to take molten pig iron from one of the two Ford blast furnaces and place it in a 400-ton mixer with a definite quantity of cast iron from a battery of

Fig. 2.—Tapping the Super-Heated Iron from the Electric Furnace into the Air Furnace on the Right. An observer is reading the temperature.

Fig. 3.—The Air Furnace, Fired with Powdered Coal, into which the Hot Metal from the Electric Furnace Flows.

cupolas. The molten pig iron is standard foundry iron. The metal from the cupolas is the result of melting some pig iron with varying amounts of steel and iron scrap. The usual quantity of steel scrap is about 15 per cent though larger percentages can be, and sometimes are, used. As high as 40 to 45 per cent of pig iron from the blast furnaces is not uncommon in charging the mixer.

At this point the composition of the metal in the mixer is definitely determined by analysis. Regulation of the proportions of blast furnace and cupola iron are such that the composition desired is readily obtained. This composition, changed but very little by subsequent operations, is approximately as follows:

Composition of Metal for Cylinder Blocks

	Per Cent
Carbon	3.15 to 3.35
Manganese	0.60 to 0.80
Silicon	1.80 to 2.10
Sulphur	0.100 max.
Phosphorus	0.25 to 0.32
Copper	0.50 to 0.75

Fig. 4.—The Pouring Truck Receiving Hot Metal from the Air Furnace. The mechanism for regulating the travel of the truck or trough is operated by one man. An observer takes a record of the temperature.

Copper as an Alloy in the Iron

This is a regular gray iron composition except for the copper content. In the early development of this cylinder block iron, copper was not a constituent. It has recently been added to bestow such qualities as higher physicals, more anti-fatigue or shock resistant properties, as well as increased fluidity and wear resistance.

The composition of the iron at the mixer having been determined as satisfactory, the hot metal, then at a temperature of about 2400 deg. F., is taken by means of a hot metal ladle to a 20-ton electric furnace, into which it is dumped. In this furnace the iron is super-heated to about 2630 deg. F., which has been determined as the suitable pouring temperature. The 20 tons are kept in the electric furnace from 20 min. to ½ hr.

Iron Finished in an Electric and an Air Furnace

At this point comes one of the rather novel features of the entire operation. In front of the electric furnace, as shown by the plan drawing, is a 25-ton specially designed air furnace, fired with pulverized coal. Into this, at intervals of every 20 to 30 min., the hot metal flows by gravity from the electric furnace—not less than 40 tons an hour. Very little alteration in composition of the metal takes place in either the electric or the air furnace, though there is some refining action in the electric. The air furnace is largely a heating reservoir for the pouring operations which follow. And this is the major feature of the continuous process.

How the Continuous Flow Is Regulated

From the time the super-heated metal leaves the electric furnace until it reaches the molds, there is no interruption in its flow. Ford engineers have perfected a novel apparatus which receives the metal as it flows in a trough from the air furnace—a movable pouring truck or ladle—which is so synchronized in its longitudinal and rotary motion that it receives metal continuously and discharges the metal intermittently to the molds as they travel along beside the ladle truck (or trough) on the mold conveyor reel. As shown by the drawing, there are two such streams of hot metal, one from each end of the air furnace,

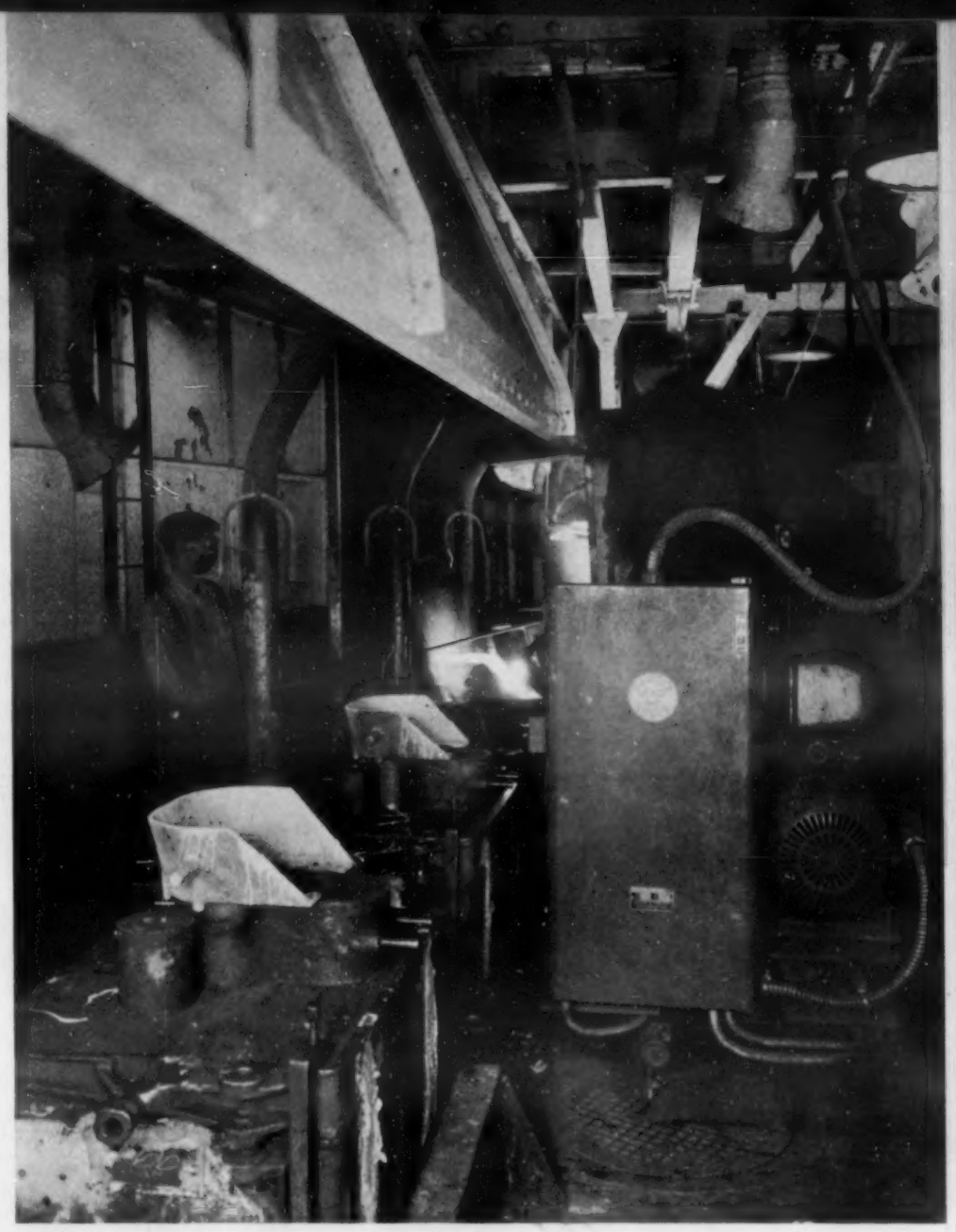

Fig. 6.—Another View of the Metal Flowing from the Movable Truck into the Molds as they Move Along, One after the Other, on the Conveyor.

Fig. 5.—Metal from the Movable Truck Flowing into the Procession of Molds.

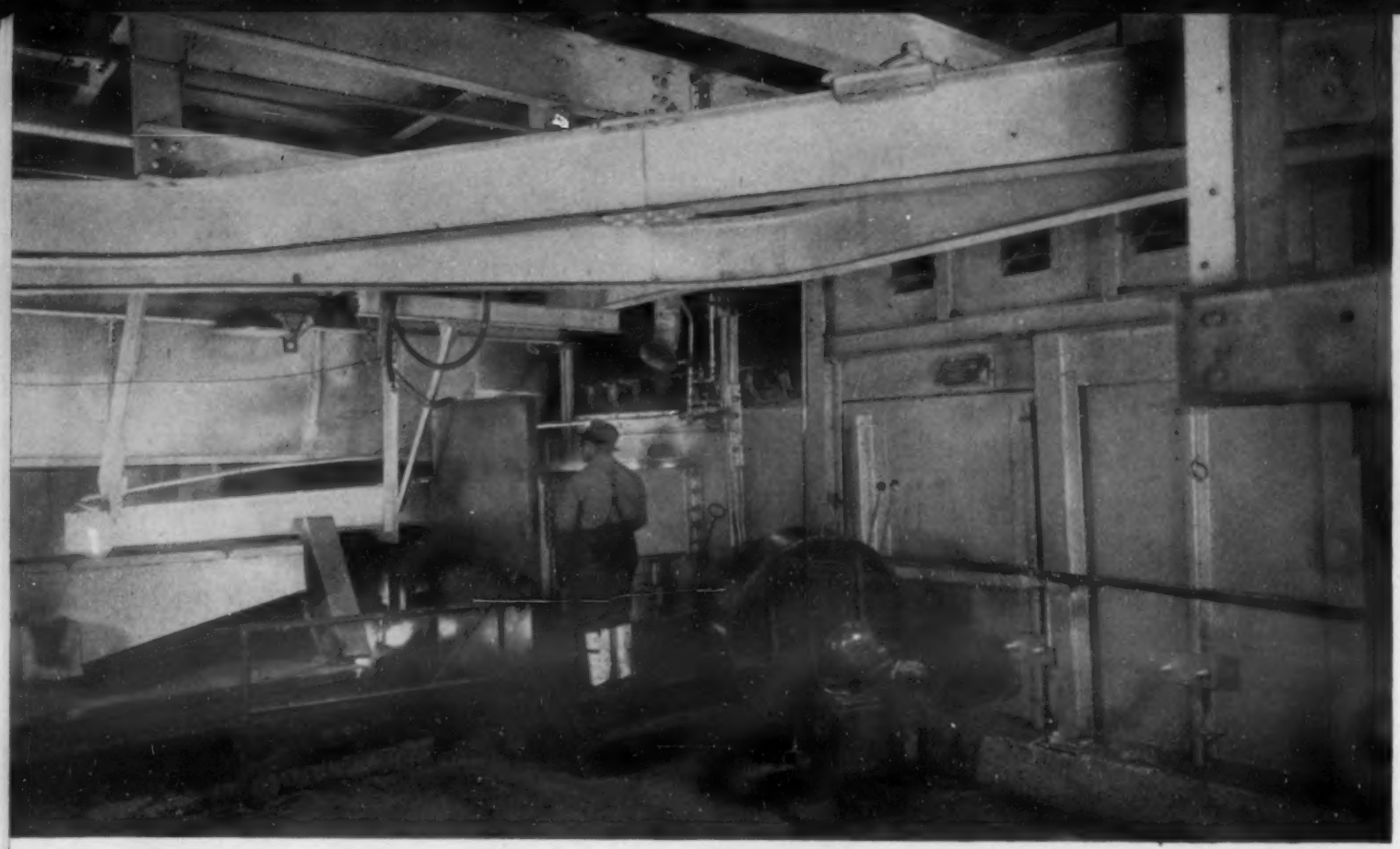

Fig. 7.—A Close-Up View of the Pouring Trough and the Metal as it Comes from the Air Furnace. The tap hole at the bottom of the trough is for removing metal and slag when the continuous operation is stopped.

delivered by the two pouring trucks to two processions of molds.

Advantages of the Continuous Pouring

Previous to this arrangement of continuous pouring, the hot metal was taken from the electric furnace in ladles and poured into the molds as they traveled along on the conveyors. There was a loss of time as well as of temperature. The introduction of the air furnace with its two continuous streams of metal has resulted in the following advantages:

Closer control of the temperature of the iron.

An increase in the capacity of the electric furnace of 100 per cent.

Elimination of ladles and labor to handle them—hence a saving in cost.

If anything, a better control of the composition—and a better metal.

An increase in the number of molds poured per day.

This method of continuous production and pouring of the cast iron has been in successful operation since early in August. There is under consideration the elimination of the electric furnace with a consequent further reduction in costs. If this plan is carried out, the hot metal will flow directly from the mixer to the air furnace where it will be super-heated and then flow on continuously as at present. It is believed that the problem of a high temperature, so essential a factor in modern high-grade cast iron, can be solved without the electric furnace as a super-heater.

The method of producing the molds for the cylinder blocks has been described in the technical press. This in itself is an impressive operation. The preparation and drying of the cores, the assembling of the flasks and molds, the preparation and drying of the cores by men assigned their individual tasks as the molds are carried by them on two long lines of conveyors, is one continuous procession. As the molds approach the pouring trough, they are entirely ready for the continuous stream of cast iron. After pouring they proceed in an opposite parallel line to the knock-out and cleaning departments.

Metal and Molds Meet at One Point

Thus two continuous streams—one of molds and one of hot metal—meet at two central points. At each pouring station, 115 molds are poured per hour, each mold consuming about 315 lb. of iron. The whole operation is an impressive example of mass production of high-grade cast iron, closely controlled as to composition and pouring temperature, and of mass production of cast iron cylinder blocks, at a minimum of cost. The evolution of this process from the eariler cruder methods of handling the metal and producing the castings is a fine example of the results of applied metallurgical and engineering research.

Fig. 8.—A More General View of the Continuous Pouring Apparatus. The hot metal is seen flowing from the air furnace into the trough. It passes out at the right into the molds as the trough is synchronously tipped.

The Role of Patents in Modern Metallurgy

By ANTHONY WILLIAM DELLER

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THE DEVELOPMENT OF MODERN industry is based principally upon research, devoted to making inventions and discoveries. The expansion which has occurred during the twentieth century has been stimulated by our patent system which offer protection for inventions and a monopoly for a limited period as a reward for the disclosure of new discoveries to the public. Since 1900 changes in industrial conditions have created new demands which have been met by inventions, and through new inventions new industrial demands have been created every year. Under modern conditions, the process of evolution in the metallurgical arts has been accelerated.

Today practically every large metallurgical company has a research staff whose sole duties are to experiment and to invent and discover. Much industrial research is being conducted in such institutions as the Mellon Institute and Battelle Memorial Institute. The National Bureau of Standards has been doing work on fundamental principles of great importance to science and industry.

Inventions and discoveries may be handled in various ways depending upon the particular conditions. In the event that the discoverer or owner of the new invention does not desire to preserve his property rights, he may dedicate the discovery to the public and industry. In some instances, it may be desirable for commercial reasons to keep the discovery a trade secret. Generally inventions are protected by securing letters patent, which consequently assume an important role in modern metallurgy.

The millions of dollars expended annually by metallurgical companies to develop new inventions are generally protected by patents in an endeavor to monopolize the field and to exclude competitors. The profits and dividends or, in fact, the existence of a company may depend upon the inventions made by research or production metallurgists, and the protection of the inventions by patents.

Novelty and Metallurgical Literature

Novelty is one of the essential factors of a patentable invention. In the early days, it was a relatively simple matter to ascertain the extent of published knowledge in any given art. Thus Agricola in the sixteenth century published his classical "De Re Metallica" which was the first systematic treatise on metallurgy and which represented a practically complete compilation of the then existing knowledge on the subject. In the seventeenth century Barba contributed his "El Arte de Los Metales" as the earliest American book on metallurgy. Even as late as the nineteenth century the standard works on metallurgy were comparatively few, consisting essentially of treatises by Karsten (1831) and Kerl (1869) in Germany, Percy in England, and Overman (1852) and Osborn (1869) in America.

In contrast to the simplicity of the preceding centuries, the literature in the twentieth century became extremely complex with every field having its own special publications. The task of ascertaining the novelty of inventions and discoveries under present conditions is one requiring great care and thoroughness. With the growth of the twentieth century literature in the metallurgical field, the collection of patents in the Patent Office provides a central source of information, enabling the metallurgist to plan his research program more efficiently and intelligently, and providing him with new ideas.

Typical Patents

Metallurgists may obtain patents for inventions relating to compositions of matter, articles of manufacture, arts or processes, machines, and improvements thereof. For a better understanding of the foregoing classification, as interpreted by our courts, reference will be made to some recent and famous decisions in metallurgical cases.

"Silcrome" valve steel was patented by Armstrong as a composition of matter and as an article of manufacture and was commercialized by Ludlum Steel Co. The patents contained claims directed to an alloy steel of high surface stability when cooled down from a high temperature and containing certain percentages of chromium, silicon, and carbon, and to a valve for internal combustion engines made from such an alloy steel. The court upheld the patenting of an alloy steel as a composition of matter and a valve as an article of manufacture.[1]

Haynes' Stellite patent was sustained for a composition of matter comprising an alloy of cobalt, chromium, and tungsten, from which high speed metal-

cutting tools could be made.[2] Other cases upheld metallurgical products as being patentable as compositions of matter. Thus Welsbach's pyrophoric alloy[3] containing cerium alloyed with iron, and Willson's calcium carbide[4] were both declared to be patentable. It is to be noted that a composition of matter covers substances which may be constituted of one or more elements either in the form of mechanical mixtures, chemical compounds or alloys.

In contrast to the foregoing cases, Belais' "White Gold" composed of 75 to 85 per cent gold, 10 to 18 per cent nickel, and 2 to 9 per cent zinc, was held to be unpatentable for want of invention over prior gold alloys.[5] Similarly, Churchward's "Alloy Steel,"[6] containing small proportions of nickel (1-3.5%), chromium (0.5-2.5%), vanadium (0.05-1.5%), and manganese (0.15-1%), as defined by claim 3 of U. S. Patent No. 868,327, was held to lack patentability over his former patent No. 845,756 on a steel alloy containing the same metals within practically the same ranges, as defined by claim 1 thereof, to wit: Nickel (1-3.5%), chromium (0.5-2%), vanadium (0.05-0.25%), and manganese (0.15-0.70%). In the Churchward Case, the court said:

> "Patentable novelty may reside either in the elements of alloys or in the proportions of the elements. * * * But novelty of proportions in the sense of the patent law involves something more than figuring out proportions differing from any that were known before. It involves new results from new proportions, developing a new metal, or, it may be, an old metal with new characteristics of structure or performance, embracing entirely new, or at least substantially enhanced qualities of utility."

The Stainless Steel Case

In the Stainless Steel Case an article of manufacture was under consideration. The Haynes patent for a wrought metal article and the Brearley patent for cutlery consisting of acid-resisting or stainless steel were involved. The Haynes article comprised a wrought metal tool having a polished surface of the incorrodible character of noble metal and composed of an alloy of iron and chromium containing 8 to 60 per cent of chromium and 40 to 92 per cent of iron with carbon in amount between 0.1 to 1.0 per cent, whereas Brearley defined his invention as a hardened and polished article of manufacture composed of a ferrous alloy containing 9 to 16 per cent chromium and carbon in quantity less than 0.7 of 1 per cent. These patents were held to be not anticipated and valid.[7]

In the Adamite Case, an article of manufacture was thoroughly discussed and distinguished from old alloys only accidentally having the same analyses. The Speer and Forster patent for an iron alloy named "Adamite" was held to cover a new article of manufacture which was different from but which possessed characteristics of both cast iron and steel. Speer and Forster claimed "Adamite" as a new article of manufacture composed of an alloy comprising essentially silicon (0.10 to 2.00%), chromium (0.5 to 1.50%), nickel (0.25 to 1.00%), sulphur not exceeding 0.05 per cent, phosphorus not exceeding 0.12 per cent, manganese not exceeding 0.45 per cent, total carbon (1.25 to 3.50%) and iron approximately sufficient to complete the 100 per cent.[8]

A classic case involving an article of manufacture is the Chromel Case. Marsh discovered and obtained a patent for an electric resistance element composed of an alloy of one of the metals of the chromium group with nickel, the latter comprising more than 50 per cent of the alloy. Although it was shown and admitted that the alloy *per se* was old, nevertheless the application of the alloy as an electric resistance element was novel and involved new results. The Marsh discovery that chromel was far superior to any previously known electric resistance element except platinum, the price of which precluded its commercial use, resulted in greatly advancing the art and constituted a patentable invention even though the alloy itself was known.[9]

A similar holding was made in the Carburizing Box Case in which it was found that an alloy containing nickel and chromium and was old, but that the patentee had discovered a new property, namely, non-carburization in the old alloy, making it especially applicable as a carburizing box.[10]

The mere substitution of a material in making a machine part or an article of manufacture is not invention unless it involves a new mode of construction or develops a new and unobvious use and property. Horgan found that an arm of aluminum alloy was very useful in a clicking machine which is used in the manufacture of shoes. The court held that a mere substitution of materials, namely, an aluminum alloy for another metal, was involved without a new mode of construction or without utilizing a new and unobvious use and property. Accordingly, the patent was held to be void for want of invention.[11]

In this case as well as the foregoing cases, an article of manufacture implies a large variety of things, and, generally speaking, may be said to include whatever is made by art or industry of man. The Supreme Court held that "manufacture implies a change, but every change is not manufacture, and yet every change in an article is the result of treatment, labor and manipulation. But something more is necessary . . . . There must be transformation; a new and different article must emerge 'having a distinctive name, character or use'."[12]

The Chromium Plating Case

An art or process was involved in the Chromium Plating Case. Fink discovered a process for plating chromium on a commercial scale continuously and consistently with satisfactory results, and particularly discovered the root of the difficulty confronting the art and a remedy therefor. As an essential operation, Fink found that the ratio of CrO_3 to SO_4 had to be regulated within critical limits. The Fink process was held to be a patentable one. This case reiterated the important principle in patent law that in mechanical cases one can make predictions in certain instances, whereas in chemical cases one cannot make predictions and a result may be obtained only by experiment. The same doctrine applies to metallurgical cases where reasoning by analogy cannot be resorted to with certainty.[13]

In the Parkerizing Case, a process was involved for rust-proofing steel. Parker found that dilute solutions of phosphoric acid could be used for the treatment of steel sheets to make them rust proof. A patent to one Ramsden was set up as an anticipation. Ramsden stated that he immersed steel wire in glacial phosphoric acid dissolved in water. He made the statement that the process in a great measure prevented the treated steel wire from rusting and in some cases very much increased the temper thereof. It was demonstrated that Ramsden never attempted to use his idea, otherwise he would not have mentioned the in-

crease in temper, which was admitted to be untrue. An important rule was enunciated in the case which applies to patents generally and to processes particularly, that a prior reference, to be sufficient for use as an anticipation, must be so clear and definite as to enable any person skilled in the art to reach the patented invention certainly, directly and without the necessity of any experiment, and that the rule is enforced with particular strictness when the alleged disclosure is found in a prior foreign patent or publication.[14]

The Hall and the Jones Processes

Many of the classic metallurgical processes have been involved in patent suits. Thus, the Hall process of manufacturing aluminum was contested. In one of the claims of the patent, Hall claimed his invention as "an improvement in the art of manufacturing aluminum which consisted in dissolving alumina in a fused bath composed of the fluorides of aluminum and a metal more electro-positive than aluminum, and then passing an electric current through the fused mass." This process was held to be a patentable invention and not anticipated by the prior art.[15]

Similarly, the Jones process involving mixing molten iron and holding it in a vessel was a patentable invention. It was demonstrated that, prior to the advent of the Jones process, defects and failures in iron and steel were due mainly to non-uniformity. Jones found that the use of a dominant pool containing so large a quantity of molten iron as to be capable of absorbing variations in the metal received from blast furnaces tended to produce an iron with greater uniformity which could be discharged to converters. Steel made from iron treated by the Jones process was shown to possess better qualities and was safer as a material of construction, especially for bridges, railroad rails and the like.[16]

In the Jones Case as well as the foregoing cases, processes have been referred to. The patent statutes, however, only include the term "art," but the courts have held that this term is synonymous with process or method. An art has also been defined as a mode of treatment or series of acts to be performed in order to produce a desired result.

A machine was involved among other things in the Steckel Rolling Mill Case.[17] It is to be noted that the term "machine" as used in the patent statutes is used in a broad sense and not in the conventional narrow one. Thus, a machine may be defined as "an instrument composed of one or more mechanical powers and capable when set in motion of producing by its own operation certain predetermined physical effects and as an artificial organism governed by a permanent artificial rule or action receiving crude mechanical force from the motive power and multiplying, or transferring, or transmitting it according to the mode established by that rule"; or "every mechanical device or combination of mechanical powers and devices to perform some function and produce a certain effect or result." Usually machine inventions are comparatively simple as the constructions may be readily understood from drawings and the function of the elements used in the constructions easily analyzed.

Safeguarding Inventions

In view of the fact that, under present conditions, the profit with which an industry may be conducted or the very existence of the industry itself may depend upon sound patents, certain rules should be followed in conducting research, in formulating the specification of a patent application, and in drafting the claims thereof. At the outset, the planning of a research program should be completed only after a thorough search of the prior art. In this manner the extent of the experiments and the scope of the field can be determined. During the research, a complete written record should be kept daily in a book, preferably of a bound type. The metallurgist conducting the investigation should sign and date the record each day. In the event that a discovery is believed to have been made, then the record should be witnessed by several reliable co-workers or supervisors. In case a notary public is at hand, such a record should also be notarized.

In preparing the patent application for the invention, it is essential to describe the process or product or machine in such full, clear and correct terms as to enable another metallurgist skilled in the art to duplicate the results without the aid of the inventor. Every metal, element or compound which is to be covered should be included in the description together with the range of proportions, particularly those giving the best results and those giving satisfactory industrial results. In case of a process, all of the operating conditions should be set forth with the full range of temperature and the like intended to be covered. The claims should not only embrace the broad aspects of the invention but should cover the optimum and specific conditions. During the prosecution of the patent application or during the establishment of a patent situation, it is usually desirable not to make any premature publication.

What Is an Invention?

Our courts have enunciated certain principles which are especially applicable to metallurgical patents and which may be used as guides in determining the patentability of a new metallurgical invention or discovery. Some of these doctrines may be found in the cases discussed herein, some in other decisions not specifically referred to. Thus, if a metallurgist contributes new teachings and adds to the knowledge of the art, especially when a new industry is created, undoubtedly a patentable invention has been made. Should a metallurgist supply a long felt want, it is indicative of a patentable discovery. Where a large number of investigators are interested in solving a problem confronting an art, particularly if the results of such investigations have not yielded any industrial results, a metallurgist solving the problem probably has made an invention.

It is to be borne in mind that in dealing with a metallurgical problem reasoning by analogy cannot be used to forecast results in an untried field. If the problem under consideration involved latent difficulties and the inventor first discovers the difficulty and then discovers means for overcoming that difficulty, an invention usually has been made. The application of an old method to a new and non-analogous field may be patented. The mere publication of bare laboratory experiments incapable of industrial use, especially if abandoned, is not anticipation of a commercial process capable of being carried out on an industrial scale. Similarly, publications which are so ambiguous and vague that the results to be obtained by following them are uncertain do not anticipate a subsequent discovery. If a use were accidental or unwitting or unappreciated, then such use does not anticipate an invention which intentionally and deliberately utilizes some principle and makes it available to the art.

It is not necessary for an inventor to describe things

known in the art in the specification of a patent. In the event that a patentee makes an erroneous explanation of the principle or theory underlying an invention, it is not fatal unless the claims are based upon and incorporate that theory or principle. In all cases, the test of invention is whether the thing in question is obvious or not to one skilled in the art. The phrase "one skilled in the art" or "man skilled in the art" is always a relative one and no absolute definition can be given. A man skilled in any particular art is itself a question of fact and one to be decided with respect to the patent under consideration. In the Stainless Steel Case, it was held that a man skilled in the art was one accustomed to the art of making steel and not one such as a cutler who is concerned only with the forming of steel into implements of industry.

In concluding these principles, it should be borne in mind that in the law of patents "it is the last step that wins" and the metallurgist who turns failure into success and takes the last step in an art is usually considered an inventor.

References

[1] Ludlum Steel Co. v. Terry, 37 Fed. (2nd) 153.
[2] Haynes Stellite v. Chesterfield, 22 Fed. (2nd) 635.
[3] Treibacher-Chemische Werke v. Roessler-Hasslacher, 219 Fed. 210.
[4] Union Carbide v. American, 181 Fed. 104.
[5] David Belais, Inc. v. Goldsmith Bros., 6 Fed. (2nd) 930.
[6] Bethlehem Steel Co. v. Churchward Steel Co., 268 Fed. 361.
[7] American Stainless Steel v. Ludlum, 290 Fed. 103.
[8] Pittsburgh Iron & Steel Co. v. Seaman Sleeth Co., 248 Fed. 705.
[9] General Electric v. Hoskins Mfg. Co., 224 Fed. 464.
[10] Driver-Harris v. Hardite Metals, Inc., 28 Fed. (2nd) 413.
[11] United Shoe Machinery Co. v. Ferree Co., 60 Fed. (2nd) 567.
[12] Brogdex Co. v. American Fruit Growers Co., 75 L. Ed. 801.
[13] United Chromium, Inc. v. International Silver Co., 53 Fed. (2nd) 390, 60 Fed. (2nd) 913.
[14] Parker Rust Proof Co. v. Ford Motor Co., 6 Fed. (2nd) 649.
[15] Pittsburgh Reduction Co. v. Cowles Electric Smelting & Aluminum Co., 55 Fed. 301.
[16] Carnegie Steel v. Cambria, 185 U. S. 403.
[17] Cold Metal Process Co. v. United Engineering Co., 68 Fed. (2nd) 564, 3 F. Supp. 120.

Abbreviations: "Fed." indicates Federal Reporter, "Fed. (2nd)" indicates Federal Reporter, Seconod Series, "U. S." indicates U. S. Supreme Court Reports, "L. Ed." indicates Lawyers Edition, "F. Supp." indicates Federal Supplement.

GENERAL REFERENCES

Robinson: Patents.
Walker: Patents.
Curtis: Patents.
Corpus Juris: Patents (Volume 48).
Deller: Principles of Patent Law for The Chemical & Metallurgical Industries.

EDITORIAL COMMENT

(*Continued from page A 25*)

an average thickness of plating. This practice is based on the reasonable assumption that a plated coating is as good as its thinnest part. Practically, on very irregularly shaped articles, a given minimum thickness may be a more severe requirement than double that average thickness. Here again, it remains to be seen whether the proposed methods of measuring the minimum thickness will prove convenient and reliable, and whether the plater can readily obtain the specified minimum thickness, if necessary by special arrangements of racks and anodes. The new requirement places a premium on uniform distribution of coatings. This need will in turn encourage more study of the throwing power and efficiency of plating baths, and improvements in the design of plating racks and tanks.

Another novel feature of these specifications is their slight dependence on accelerated tests. The salt spray test is still specified for nickel and chromium finishes, (for which it serves as a porosity test), but is omitted for zinc and cadmium coatings. This decision was based on the conviction that the present accelerated tests are of doubtful value and may be misleading. Until more discriminating and more significant accelerated tests are available, the minimum thickness of a deposit is probably the best criterion of its protective value.

In a recent address to the American Society for Testing Materials, C. F. Hirschfeld stressed the importance of research work as a basis of specifications. This need is well illustrated in the plating industry, which wisely postponed adoption of these standards till definite data were available. It is expected that similar formal specifications for plating on non-ferrous metals will be prepared when exposure tests of specimens that are now being prepared are completed. It is sometimes necessary, however, for manufacturers, consumers, or organizations to adopt some kind of specification before exact data are available. In such cases it is usually justifiable to base the requirements upon present good practice, again leaning toward high standards. Such "working specifications" should be clearly distinguished from the more formally established standards. Their use for a few years will probably furnish experience that will be valuable in the preparation of more permanent standards.

The most important factor in the success of any specification is the extent to which it is used in the actual checking of deliveries. Unless this is done regularly and systematically, it is impossible to decide subsequently whether failure of a particular coating is evidence of inadequacy of the requirements, or merely of failure to meet those requirements. For a few years at least, more tests should be made than may be necessary after the specifications are more generally accepted and observed. The responsibility for the application, and if necessary the modification, of the specifications therefore rests at least as much upon the chemists and metallurgists who designate and check the requirements as upon the platers who must work to meet them.—W. Blum.

The Cadmium Scarcity

A DEVELOPMENT of far-reaching influence is the present scarcity of cadmium. Before the use of this metal by the plating industry increased a demand for it, it had but few industrial applications. As a by-product in the refining of zinc ores, it was allowed to pass into the discard. The perfection and greater use of the electrolytic refining of zinc ores increased the supply which was rapidly taken up for plating and a few other purposes.

But this is not the chief cause of the present scarcity. The development of the nickel-cadmium and the silver-cadmium alloys and their rather extensive industrial application as bearings has drawn so largely upon the available supplies of cadmium that the price has advanced to over 85 cents a pound. Some automobile companies are using the silver cadmium alloy as bearings on a large scale.

While the present condition is disconcerting, particularly to the plating industry, doubtless the situation will be corrected in due time by the discovery of new supplies or by some other solutions. The law of supply and demand is still working, despite some theories and practices which seem to be trying to alter it, and if left alone it will ultimately alleviate the cadmium scarcity.—E.F.C.

Phosphorus as an Alloying Element in Steel—II

A Correlated Abstract

By H. W. GILLETT

Part I of this correlated abstract was published in the October issue. This installment concludes the discussion by Dr. Gillett. In a subsequent issue, probably December, the subject will be treated further by C. H. Lorig, metallurgist of the Battelle Memorial Institute, Columbus, Ohio, in an article "An Experimental Study of Phosphorus as an Alloying Element in Low-Carbon, Low-Alloy Steels."—EDITOR.

Copper-Phosphorus Steels

The rust coating upon Cor-Ten is said to be smoother, harder and more adherent than that upon an ordinary steel.

Study of steels alloyed with copper and phosphorus has also gone on in Germany at the Vereinigte Stahlwerke. This is summarized by Gregg and Daniloff,[1] from the available patent literature, technical publications not having yet appeared. In British Patent 370,064 the following figures are given in Table I.

Table I—Composition and Properties of Steel in British Patent

C	Si	Mn	S	Cu	P	Tensile strength, lb. per sq. in.	Yield strength, lb. per sq. in.	Yield ratio, per cent	Elongation, per cent	Reduction of area, per cent	Specific impact resistance, mkg. per sq. cm.
0.09	0.11	0.50	0.05	0.64	0.14	73,000	56,000	77	23½	50	10-13
0.09	0.11	0.50	0.05	0.64	0.22	76,000	63,500	83	25	55½	10-12
0.09	0.21	0.57	0.05	0.64	0.24	80,000	62,500	78	24	52	10-12

Thus the tensile and yield strengths are improved by phosphorus without loss of static or impact toughness. The yield ratio reported by Hunt and by d'Amico of around 70 for plain phosphorus steels has been brought up to around 80 by the addition of copper.

Patent Claims for Phosphorus-Containing Steels

Some of the patent claims are summarized in Table II.

Besides the usual use of phosphorus in free-machining carbon steels, its introduction up to 0.15 per cent into the stainless Cr steels has been suggested by McIntosh [U. S. Pat. 1,730,780 (1929)] for 11-15 per cent Cr steels and by Palmer [U. S. Pat. 1,961,777 (1934)] for austenitic Ni-Cr steels of the 18:8 and more highly alloyed types. Both McIntosh and Palmer also use high sulphur in conjunction with the high phosphorus to produce easy machinability.

Behavior of Phosphorus-Containing Steels in Impact

Feild [28] studied low-phosphorus (0.02 per cent P) and high-phosphorus steels (0.12 to 0.17 per cent P) with carbons running from 0.17 to 0.79 per cent, in the annealed condition. The high-phosphorus series was studied with and without the addition of 0.15 per cent zirconium. He found that the impact value without zirconium was approximately halved by the extra 0.15 per cent P, on the addition of zirconium it rose to approximately 75 per cent of the value shown by a low phosphorus steel of a given carbon content. Zirconium was thus classed as a "neutralizer" of the embrittling effect of phosphorus in the medium and high-carbon steels.

The tendency of Bessemer steel toward brittleness is often ascribed to its phosphorus content. Bessemer steel is susceptible to a certain degree of age hardening. Bolsover [29] found that a 0.20 per cent C, 0.11 per cent P steel was more embrittled by reheating after cold work than similar steels lower in phosphorus. In discussion of this paper Service remarked that deoxidation practice might have more to do with brittleness than chemical composition.

Epstein found that open-hearth steel, low in nitrogen, to which phosphorus was added was less embrittled on cold work and reheating to 450 deg. C than Bessemer steel of higher nitrogen and similar phosphorus contents. Kühle [30] found a steel of 0.09 per cent P to show more susceptibility to aging than one of lower phosphorus but produced no evidence that the phosphorus was responsible.

As Fig. 5 shows, the room temperature solubility of phosphorus in alpha iron is around 1 per cent, and while some authorities have considered this figure a trifle high, it seems to be well substantiated. Köster [31] obtained precipitation hardening in an alloy of 0.06 per cent C and 1.50 per cent P, as he should from Haughton's diagram, but only on reheating to a temperature well above that at which precipitation hardening is met in Bessemer steel. Thus it appears that, in carbon steels with less than around 1 per cent P, there are no known precipitation hardening effects due to P alone and the cause for brittleness must be sought elsewhere. Motok [32] examined Fe-P alloys up to 0.40

Table II.—Patent Claims for Phosphorus-Containing Steels

Composition Limits				Purpose	Patent Number
Carbon, per cent	Phos., per cent	Copper, per cent	Other Elements, per cent		
0.3	0.1 to 0.4	0.1 to 1.0		Structural.	French 708,971 (1931), Vereinigte Stahlwerke.
0.10	0.1 to 0.25	0.25 to 0.7		Structural. Cu to overcome brittleness.	British 370,064 (1932), Vereinigte Stahlwerke.
0.2	0.3	0.25 to 0.7	Al* 0.05 to 0.2	Structural. Cu and Al to overcome brittleness.	British 373,640 (1932), Vereinigte Stahlwerke.
0.05 (max.)	1.0	2.0	Si 1.0	Corrosion resistance.	British 365,538 (1932), Vereinigte Stahlwerke.
0.12 and over	0.08 to 2.0	0.4 to 1.5	Cr 2.0; Ti 1.0	Especially for rails; stated to have good wear resistance and impact properties. Ti as aid against embrittlement.	French 720,035 (1931), Vereinigte Stahlwerke.
0.2	0.05, 0.75		Cr up to 3.0	Structural. Cr to overcome brittleness.	French 728,648 (1932), Vereinigte Stahlwerke.
0.05 to 0.30	0.08 to 0.30		Cr 0.25 to 1.5	Cr to overcome brittleness.	U. S. 1,979,015 (1934), E. H. Schulz, Vereinigte Stahlwerke.
0.05 to 0.20	0.08 to 0.25	0.25 to 1.0	Mn 0.60 to 1.6	For rails.	U. S. 2,002,932 (1935), H. Buchholtz, Vereinigte Stahlwerke.
0.01 to 0.60	0.07 to 0.75	0.15 to 3.0	Cr 0.30 to 3.0 Si 0.25 to 3.0 Mn 0.02 to 0.50		U. S. 2,006,304 (1935), J. Strauss.
low	0.14		Zr 0.02 to 0.50	Zr to overcome brittleness due to P.	U. S. 1,546,881 (1922), F. M. Becket.
.....	.....		B 0.001 to 0.1	High P content is neutralized by as little as 0.02 per cent B.	U. S. 1,519,388 (1924), Richard Walter.
low	0.40		Si 1.4	Transformer sheet.	French 638,053 (1927), Vereinigte Stahlwerke.
Basic Bessemer Steel	0.2 to 0.5		S 0.15	Screw stock.	Swiss 144,060 (1929), French 677,967 (1929), British 350,888 (1930), F. Borggraefe.
0.06 to 0.10	0.30 to 0.50			Screw stock.	German 317,671 (1918), H. Lütke.
0.09 to 0.14	0.01 to 0.1		S 0.05 to 0.11	Screw stock.	U. S. 1,352,710 (1919), G. B. Waterhouse.
0.6	0.3		S 0.25 to 0.45	Screw stock.	French 709,828 (1931), Sachs Akt.
0.12	0.10 to 0.15		S 0.09; Si 0.3 to 0.5	Transformer sheet.	U. S. 1,692,690 (1926), S. Osser.
0.15	0.05 to 3.75		Si 0.2 to 5.0 (P ¼ to ¾ of Si)	Transformer sheet.	U. S. 851,635 (1905), R. A. Hadfield.

* Patent states: "Combined Al + P not to exceed 0.24 per cent if Al alone is used, while P may amount to 0.3 per cent if Cu is present."

** See also U. S. Pat. 2,004,836 (1935), to E. H. Schulz, Vereinigte Stahlwerke, for method of manufacture by the basic Bessemer process. Examples given range from 0.10 to 0.15 per cent C; 0.01 to 0.48 per cent Si; 0.50 to 0.95 per cent Mn; 0.09 to 0.10 per cent P, and 0.45 to 0.60 per cent Cr.

per cent P for age-hardening and could find none. Epstein [33] suggests that nitrogen may precipitate more readily in the presence of P.

Effect of Temperature and Grain Size Upon Impact Resistance

Impact brittleness in steel, while normally evaluated only at room temperature, is nevertheless very dependent upon the temperature of testing, as has already been pointed out in the case of silicon steel transformer sheet.

Carbon steels vary in their impact behavior over a range of temperature as is shown in Fig. 6 from Epstein.[33] The good behavior of the aluminum treated "Izett" steel will be noted in this figure.

Herty and McBride [34] have shown that in carbon steel of 0.14 to 0.22 per cent C the impact values at room temperature, and the whole shape of the impact-temperature curve, are vitally altered by variations in deoxidation practice that affect grain size. Fine grained "abnormal" steels, thoroughly killed with aluminum, and normalized from 875 deg. C. (which was not high enough to cause excessive grain growth) gave, at —20 deg. C. Charpy impact values (Izod notch) of around 120 ft.lb., while a coarse grained rimmed steel gave 5 ft.lb., a silicon killed steel 10 ft.lb., and a steel semi-killed with silicon and a deficincy of aluminum gave 40 ft.lb. Much less difference was shown in steels of 0.40 to 0.50 per cent carbon.

Such variations from grain size indicate that the primary cause of impact brittleness in phosphorus-bearing steels of low-carbon content may be the grain size and that, if means are found to make such steels fine-grained, they may have acceptable impact properties.

Segregation and Diffusion of Phosphorus

The inherent tendency of phosphorus toward coarse crystallization was recognized in 1860 by Fairbairn [35] and many times commented upon since.

Fig. 5. The Fe-P Diagram, as Presented by Haughton.[42]

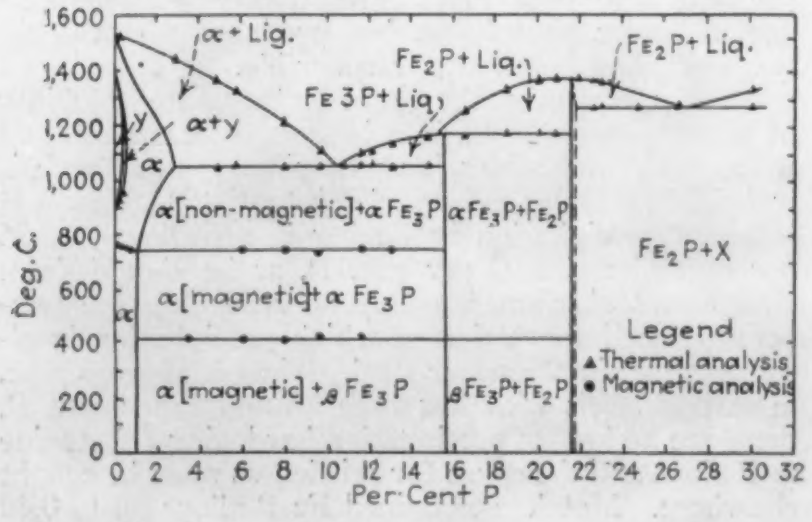
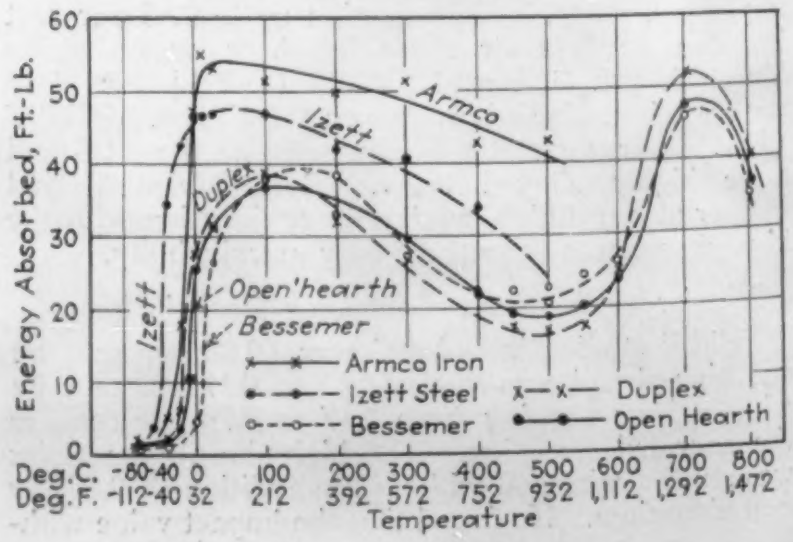


Fig. 6. Charpy Impact Resistance of Various Steels at Various Temperatures. Epstein.[33] The Bessemer steel, high in both P and N, loses toughness in impact at a higher sub-normal temperature than do the other steels.



The Fe-P equilibrium diagram shows the liquidus and solidus to be at approximately the same distance apart as in the Fe-C system. Similar opportunities for segregation and coring during solidification occur, but since phosphorus does not diffuse as rapidly as does carbon, repair of segregation and the establishment of homogeneity does not occur as readily during normal cooling.

De Kryloff[36] reported that a 0.48 per cent C steel with 0.13 per cent P had almost no ductility as rolled, but by annealing at 750 to 780 deg. C., or by oil quenching and drawing at such temperatures, it could be given good ductility. He related this to inhomogeneity due to phosphorus segregation, and found that evidence of segregation could be observed under the microscope. He concluded that at 750 to 780 deg. complete homogeneity could be obtained in a 0.40 per cent C steel with 0.07 per cent P but not with higher phosphorus.

Stead[16] devoted many years to the metallographic study of phosphorus in cast iron and steel, the hard Fe-P-C constituent found in high-phosphorus cast irons being termed "Steadite" in his honor, and a copper chloride etching reagent he used to show the inhomogeneous distribution of phosphorus is called "Stead's reagent." A long series of studies of phosphorus segregation and resultant ferrite banding ensued in which his reagent was used to reveal banding.

The mechanism of phosphorus segregation was very thoroughly discussed by Howe,[37] who explained banding by freezing and diffusion phenomena, showing that during freezing pure ferrite first separates, leaving melt richer in carbon and phosphorus between the ferrite grains, then, as the metal cools from the solidus to the transformation range, the carbon diffuses fast enough to nearly equalize its concentration throughout, while phosphorus does not diffuse rapidly and remains piled up where it was frozen out. Thus, unless a long diffusion heat treatment is given, the local concentration of phosphorus may be well above the amount shown by analysis. Northcott[38] notes a case where the dendritic axis contained 0.26 per cent C, 0.04 per cent P, while the interdendritic filling contained 0.23 per cent C, 0.10 per cent P.

Much of the fear of phosphorus in high-carbon steels is due to the fact that, while the average analysis may show it to be present in an amount that could readily be tolerated were it uniformly distributed, it may be non-uniformly distributed and areas of unduly high phosphorus may be present. Hence the phosphorus is kept down to so low a percentage that even the worst segregation will not too greatly enrich even minute areas.

Many observers believe that banded steels are not necessarily inferior, but most makers would be glad to avoid their production.

The Gamma Loop

Not only because of the slow diffusion of phosphorus, but also because phosphorus raises Ac_3, it is necessary to use higher temperatures in annealing or normalizing high phosphorus steels. That P raises Ac_3 has long been known, but only in comparatively recent times has it been realized that, like silicon and chromium, phosphorus produces a closed gamma loop and that beyond a certain phosphorus content, the alloys with iron remain alpha at all temperatures below solidification and do not pass through the austenite-ferrite transformation. Such alloys can give no grain-refinement by heat treatment.

The all-alpha Fe-Si alloys, such as steel for transformer sheet, have a marked tendency toward large grain size, and though tough at slightly elevated temperatures, they are relatively brittle at room temperature and become brittle as glass at very low temperatures. This is all fully discussed by Greiner, Marsh and Stoughton.[39]

In similar fashion, the all-alpha Fe-Cr alloys, outside the gamma loop shown by Bain[40] tend to have coarse grain size and a tendency toward brittleness. The marked effect of temperature on impact strength is, however, not confined to alloys not capable of transformation, as Wilten and Dixon[41] show for 5 per cent Cr steels.

The location of the gamma loop, and that of the crescent-shaped field for alpha plus gamma in carbon free Fe-P alloys have been plotted by Haughton[42] and by Vogel[43] as shown in Figs. 7 and 8. There is

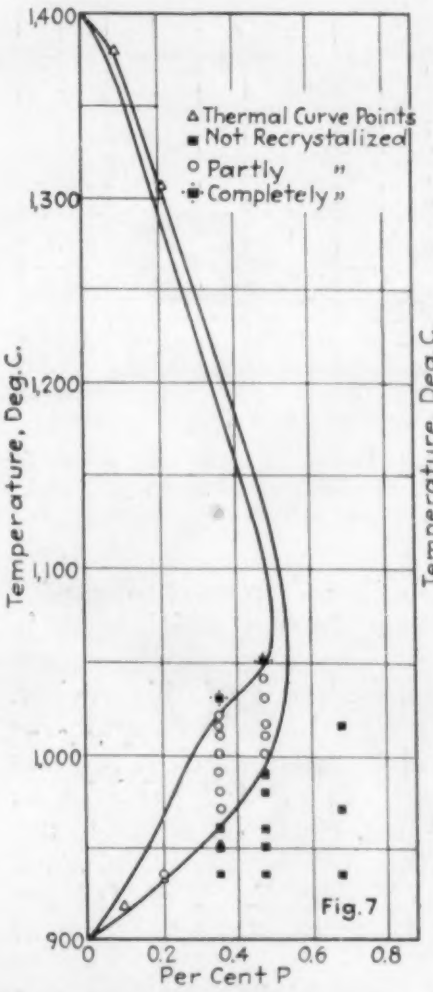


Fig. 7. The Gamma Loop as Found by Haughton.[42]

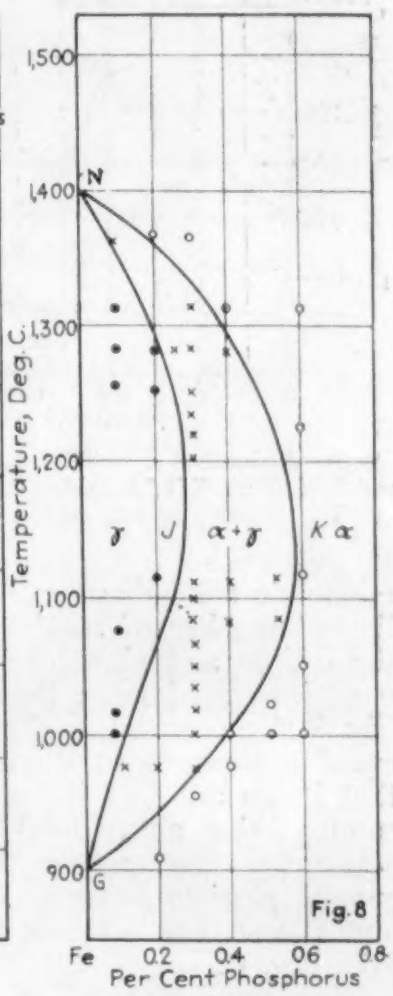


Fig. 8. The Gamma Loop as Reported by Vogel."[43]

disagreement of the two investigations. Haughton finds complete transformation from alpha to gamma on cooling an alloy of 0.5 per cent P to 1100 deg. C. and complete transformation from gamma to alpha on cooling through the range 1050 to 975 deg. C., while Vogel concludes that no alloy higher in phosphorus than 0.3 per cent can be so transformed. He has the alloy start to change to gamma at 1350 deg. C., complete this at about 1150 deg. C., and then start to change to alpha, but not to be completely changed back to alpha till 975 deg. C. has been passed. Stead[16a] used a practically carbonless alloy of 0.50 per cent P in some of his work and concluded that it did not become wholly gamma. Whiteley found that when steel of 0.18 per cent C, 0.12 per cent P was held in the $\alpha + \gamma$ range, phosphorus diffused out of the gamma into the alpha, since it is more soluble in alpha but that by holding just below Ac_3, homogeneity as to phosphorus content can be obtained.

Haughton worked with annealed specimens held at

temperature 30 min. and quenched. Vogel shows a duplex structure in an alloy with 0.3 per cent P heated 5 min. to 1000 deg. C. and quenched. It is quite probable that Haughton's results more nearly approach equilibrium conditions, Vogel's ordinary conditions. However, neither investigator stated the carbon content of his alloys, Haughton merely stating that he used electrolytic iron.

The Effect of Carbon

Carbon opens up the gamma loop, just as it does in the case of chromium and of silicon. Vogel shows a

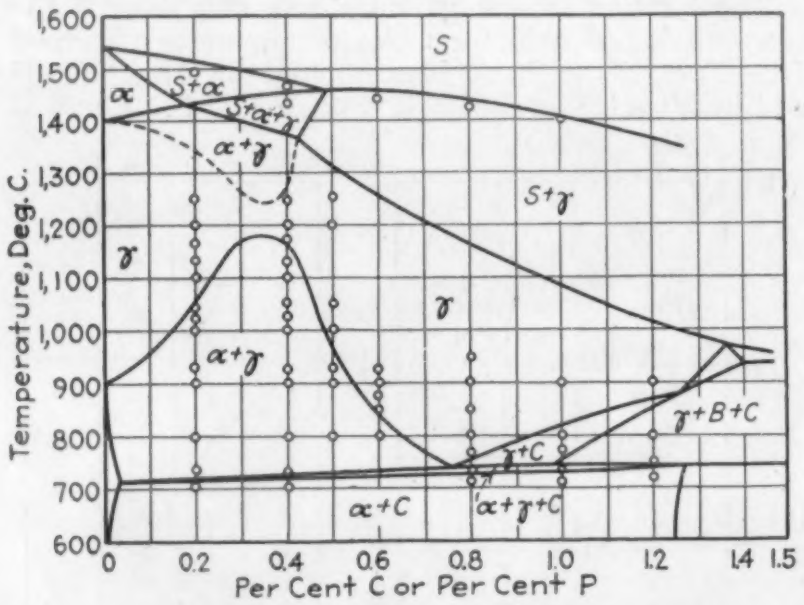


Fig. 9. A Section of the Ternary Fe-P-C Diagram, for Alloys in which % C = % P, According to the Schematic Diagram of Vogel.[43] The accuracy of this diagram is not sufficiently established.

schematic solid diagram, built up from studies of a limited number of specimens, few of which were in the carbon and phosphorus ranges in which we are most interested from the standpoint of this review. Fig. 9 shows a section through the solid diagram for equal percentages of P and C, from which it appears that in an alloy of 0.2 per cent P, 0.2 per cent C, gamma exists above 1050 deg. C., alpha starts to appear on cooling through that temperature, but some gamma persists down to 725 deg. C. With 0.4 per cent P and 0.04 per cent C, alpha starts to form at 1175 deg. C.

With pure Fe-P alloys, one might postulate that only those alloys that were wholly gamma at some temperature would show proper grain refinement, and that alloys lying in the alpha plus gamma field, in which some of the original alpha never transforms, might be brittle, and the sharp drop in impact of d'Amico's steels at just over 0.25 per cent P might be thus explained, were it not that the amount of carbon present in d'Amico's steels doubtless extended the gamma loop well beyond that figure. Possibly the height of the alpha plus gamma field, below the loop and above Ac_1 may allow too much time for the separation of ferrite and thus allow grain growth to proceed too far, in which case the addition of some element that would depress Ac_3 might help.

On the other hand, in "Cor-Ten" the chief alloying elements (beside copper) are silicon and chromium, both of which, like phosphorus, raise Ac_3 and form a gamma loop. Thus elements with an alloying tendency in the same direction as that of P are used, though the amounts of Si and Cr are far below those at which they produce brittleness by themselves. The P content of 0.10 to 0.20 per cent is close to the amount which some commentators would consider the limit without brittleness, but there is no sign of any accentuation of a tendency toward brittleness, indeed the reverse is apparently the case.

The exact mechanism of phosphorus embrittlement remains obscure, and one cannot yet predict the phosphorus limit in an alloy steel within which it is satisfactorily tough and beyond which it is impact-brittle, without actual trial.

Summary

The important phenomena in phosphorus-alloyed steels may then be summarized as follows:

1. Large amounts of carbon and phosphorus are mutually incompatible. Carbon must be kept down in high-phosphorus steels.
2. In steels of suitably low-carbon content, increase in phosphorus, within limits, raises hardness, tensile and yield strength and produces a high yield ratio, with little loss in formability by bending, or of static ductility, and, up to a phosphorus content well beyond the normal, without serious loss in impact resistance.
3. The strength and the yield ratio are also improved by copper, and the resistance to atmospheric corrosion of the copper steels is materially increased by phosphorus.
4. At some high-phosphorus content, varying according to the carbon and alloy composition of the steel, room temperature impact resistance will drop, and this will be still more marked at sub-normal temperatures. This occurs at phosphorus contents below those at which static ductility or formability are seriously affected.
5. The impact properties should be capable of improvement by methods of grain size control and by the presence of other alloying elements.
6. Segregation and slow diffusion of phosphorus introduce a tendency toward non-homogeneity in phosphorus-alloyed steels.

A further fact of some interest is that between iron-carbon and iron-phosphorus alloys of equal strength and hardness, those with phosphorus have the higher electrical conductivity, so that Stoughton[5] suggests that, for third rails on electrical railways, phosphorus affords a better hardening means than does carbon. The similarity of phosphorus steels and carbon steels, and that between phosphorus steels and silicon steels, raise the question of possible application to magnetic problems, a matter discussed by d'Amico.[18]

The chief present interest, however, is in the possible application of phosphorus as an alloying element in high-yield point, corrosion-resistant steels, valuable for mechanical properties rather than for physical properties.

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The Embrittlement of Boiler Steel*—IV

A Correlated Abstract

EVERETT P. PARTRIDGE AND W. C. SCHROEDER

Laboratory Investigations of the Failure of Steel Under Combined Stress and Chemical Attack

WITH MUCH EVIDENCE from practice indicating that chemical attack induces the failure of steel, which, although highly stressed, would not normally fail as a result of the stress alone, it is not surprising that a number of investigators have attempted to determine what combinations of conditions will lead to failure, and how failure may be obviated. For convenience, the discussion of the laboratory investigations in which steel was simultaneously subjected to chemical attack and to stress may be separated into two parts, the first covering tests in which the stress was essentially steady, and the second those in which repeated or cyclic stress was employed.

Essentially Steady Stress at Room Temperature

In a preceding section a number of investigations were reported in which steel after exposure to hydrogen was tested in various ways. Pfeil[119] noted during tensile tests that the embrittling effect of the hydrogen disappeared almost immediately after cessation of the electrolysis by which it was produced at the metal surface. His suggestion that the hydrogen was driven out by cold working during the early stages of the tension test has been substantiated by the results of Bardenheuer and Ploum.[120] This observation offers a possible clue to the apparently contradictory results from the experiments of Williams and Homerberg[121] on one hand, and, on the other, those performed for the Permutit Co. by the testing laboratories of the Department of Civil Engineering of Columbia University.[122, 123]

Williams and Homerberg[121] stressed a flat strip of steel to failure in tension at room temperature while hydrogen, continuously generated by electrolysis of a 4 per cent solution of sodium hydroxide in a cell clamped against one surface, was diffusing through the metal and being collected over distilled water at the other surface. During a period of a month the stress on the test piece was progressively increased until failure occurred. A marked increase in the rate of penetration of hydrogen was observed as the stress was increased, reaching a maximum when the yield point was passed. Photomicrographs of the metal near the fracture showed very definite intercrystalline cracks.

The tests for the Permutit Co.[122, 123] were carried out at room temperature with the same type of apparatus except that a bar with four test specimens in series was employed. An electrolytic cell containing a 4 per cent solution of sodium hydroxide was attached to the surface of the third section, and a similar cell loaded with a solution containing 2 per cent of sodium hydroxide and 2 per cent of sodium sulphate was attached in the same manner to the fourth section. The second section, which carried no cell, was intended to serve simply as a standard for comparison in the test, while the first section which was not stressed during the test, was preserved for future reference.

Each test section was 1.747 in. wide and 0.126 in. thick, so that sections Nos. 2, 3 and 4 were presumably subjected to the same stress during the test. It is quite possible, however, that the unit stresses in the individual sections deviated somewhat from each other toward the end of the test as a result of unequal deformation of the metal.

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Previous installments of this correlated abstract appeared in the June, July, and September, 1935, issues of METALS & ALLOYS.
The authors are, respectively, supervising engineer, Nonmetallic Minerals Experiment Station and research chemical engineer, Joint Research Committee on Boiler Feed-Water Studies, attached to the Nonmetallic Minerals Experiment Station, U. S. Bureau of Mines, Rutgers University, New Brunswick, N. J.

Over a period of 6 weeks the load was increased from an initial value of 25,000 to a final value of 54,000 lb. per sq. in. At this time a potentially significant difference from the procedure of Williams and Homerberg was introduced. Instead of causing the third and fourth test sections to break while hydrogen was still being liberated by electrolysis at the surface of the metal, the Columbia investigators stopped the electrolysis, removed the test strip, and loaded sections Nos. 2, 3 and 4 separately to failure.

The most significant differences in the results from the respective experiments were that Williams and Homerberg found intercrystalline cracks in the metal after failure and observed that the steel had necked down at two points, one on each side of the area where the hydrogen had been generated at the surface, while the Columbia investigators found only transcrystalline cracks at right angles to the direction of application of stress, and their test sections necked only at one place, roughly in the middle of the area covered by the cell.

An elaborate structure of theory might be built up on the basis of these differences. It seems preferable, however, to forego the theory and say that the different procedures may have caused the respective results by producing a significant difference in the hydrogen concentration in the steel as the stress approached the value at which actual failure, in the sense of observable discontinuity in the metal, began to take place. Certainly a greater opportunity for the loss of hydrogen existed in the Columbia tests.

In the Columbia report some emphasis is placed upon the fact that test section No. 4, which had been exposed to the solution containing 2 per cent each of sodium hydroxide and sodium sulphate, showed lower elongation and reduction in area than test section No. 3, which had been exposed to the 4 per cent solution of sodium hydroxide. The observed differences between 30 and 25 per cent elongation and 28.8 and 25.4 per cent reduction in area for sections Nos. 3 and 4 respectively may be significant, but a number of duplicate experiments would be necessary to make this certain. As in other cases of hydrogen embrittlement, sections Nos. 3 and 4 showed no reduction in tensile strength compared with section No. 2.

In the Columbia test the rate of hydrogen diffusion through the steel only became appreciable after the average stress had been increased slightly above the yield point. This observation, which is in general agreement with that previously made by Williams and Homerberg, suggests the possibility that slow yielding of the steel tended to break the protective oxide coating and thus continuously to expose fresh metal surfaces for the absorption of hydrogen.

Steady Stress at Boiler Temperatures

The preceding tests of hydrogen embrittlement were carried out with comparatively dilute solutions at room temperature. A number of investigations have been made in which steel in contact with solutions at elevated temperatures has been subjected to various degrees of stress.

In his early experiments, described in a preceding section, Merica[124, 125] made a few tests in which notched steel specimens were stressed to about 15,000 lb. per sq. in., calculated on the cross-sectional area at the base of the notch, while in contact with a concentrated solution of sodium hydroxide at boiler temperatures. During subsequent rotating-beam tests no difference in life was observable between these specimens and others exposed under the same conditions except for the absence of any imposed stress.

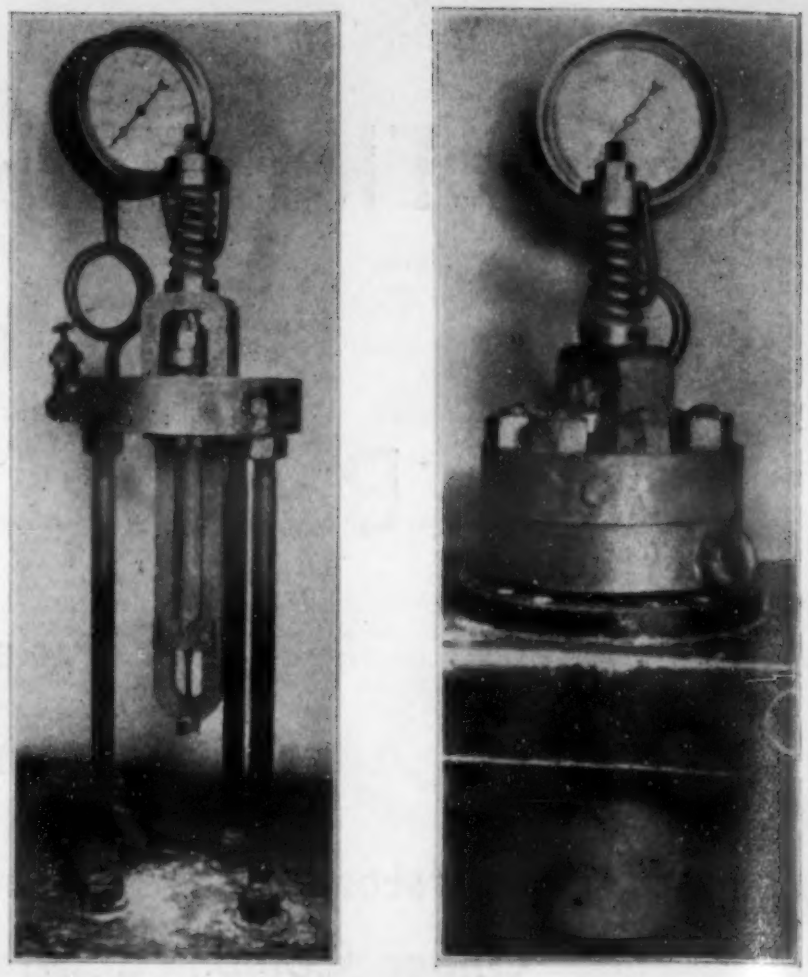

Fig. 12.—Tension Test Apparatus Used by Straub in Laboratory Studies of Embrittlement. Left, loading arrangement comprising external spring, rod passing through packing gland, and yoke to hold specimen; right, complete bomb assembly. (From *Bulletin 216*, University of Illinois Engineering Experiment Station).

Several years earlier Stromeyer[126] had briefly described some tests in which two rings of steel about 6 in. in diameter were driven tightly together so that the inner one was subjected to compression and the outer one to tension. After immersion in a hot 37 per cent caustic soda liquor in an evaporator for 3 months, the rings were removed and cut into pieces, which were tested by bending. It was found that the pieces from the outer ring were quite brittle, but those from the inner ring were still perfectly ductile. The stresses involved in this case were presumably rather high. Stromeyer published a somewhat more complete description of this experiment at a later date.[127]

That very high stresses were necessary to produce the "brittle" failure of steel exposed to various saline liquors was subsequently demonstrated in a qualitative manner by the experiments of Jones.[128] During an investigation of the failure of evaporators and other equipment used in the manufacture of ammonium nitrate, he exposed a number of riveted test plates, prepared in various ways, to a solution containing 4 parts of calcium nitrate to 1 part of water at 380 deg. F. (145 deg. C.). Out of a number of plates which were warped and indented as a result of using the minimum riveting temperature, three cracked between 23 and 28 days but the remainder had not failed after 74 days. None of a group of plates riveted in the same manner but normalized after riveting cracked in the 74-day period. Similarly, plates prepared under less drastic riveting conditions did not crack.

In another series of tests Jones used strips of mild steel 0.25 in. thick, 1 in. wide and 4 in. long, two of which were bent by fastening them together around a

1-in. cylinder of hard steel by means of bolts through holes in their ends. Test strips bent in this manner were found cracked after continued immersion in concentrated solutions of calcium nitrate, potassium hydroxide, ammonium nitrate, or sodium nitrate near their respective boiling points, but others in solutions of sodium carbonate or ammonium sulphate or in a bath of fused sodium and potassium nitrates did not crack. The addition of sodium carbonate to a solution of sodium nitrate apparently delayed cracking. Annealing the test pieces at temperatures up to 570 deg. F. (300 deg. C.) failed to prevent cracking, but other pieces annealed at temperatures above 750 deg. F. (400 deg. C.) did not crack in 50 days. In all cases of failure, the cracks were intercrystalline.

From these tests by Jones it is evident that very high local stresses were required to produce failure. The actual magnitude of these stresses cannot, however, be estimated. Moreover, it is not at all certain that the same stress was produced in each test piece, so that in certain cases cracking may not have occurred because the stress was below the necessary value. When Straub[129] used the same system in his preliminary experiments, he found that about one out of three specimens tested under supposedly the same conditions would crack, and that the residual stress on unbroken specimens varied greatly.

The extended investigations by Parr and Straub,[130, 131] later summarized by Straub[129] are so well known in the United States that this review will incline less toward description than toward interpretation. The closely related work of Ulrich[132] will be discussed at the same time.

Both Straub and Ulrich employed apparatus in which a test specimen was subjected to a tensile stress while in contact with a solution of sodium hydroxide at an elevated temperature. Straub used a bomb, shown in Fig. 12, in which the stress was transmitted by a plunger passing through a packing gland and loaded externally by a calibrated coil spring. Ulrich obviated any possibility of leakage and of uncertain loading due to friction in the packing gland by suspending weights directly from his test specimen inside his bomb, which was a long vertical cylinder, as indicated in Fig. 13. By connecting two specimens in series, Ulrich was able to examine not only the actual failure, but also the appearance of a specimen which had been close to failure. Both investigators applied the load to the specimen at room temperature and then heated the apparatus to the test temperature.

Mechanism of Failure

Typically brittle fractures with accompanying cracks tending to follow grain boundaries were produced in the tests of Straub. To explain this mode of failure, Straub adopted the hypothesis of intercrystalline corrosion. Ulrich on the other hand, did not observe any general intercrystalline attack in three series of tests conducted at a pressure of 35 atmospheres (515 lb. per sq. in.) with an average stress of 52,500 lb. per sq. in. and an average concentration of 285 grams of sodium hydroxide per liter. In his first series of tests Ulrich used specimens which had been punch-marked on the reduced section to allow measurement of the elongation. In every specimen which failed, the crack originated at one of these punch marks, and fine cracks were found at the other mark, as well as at the marks on the companion specimen loaded in series. Apparently the stress concentration at the base of the small hole was responsible for initiating the process of

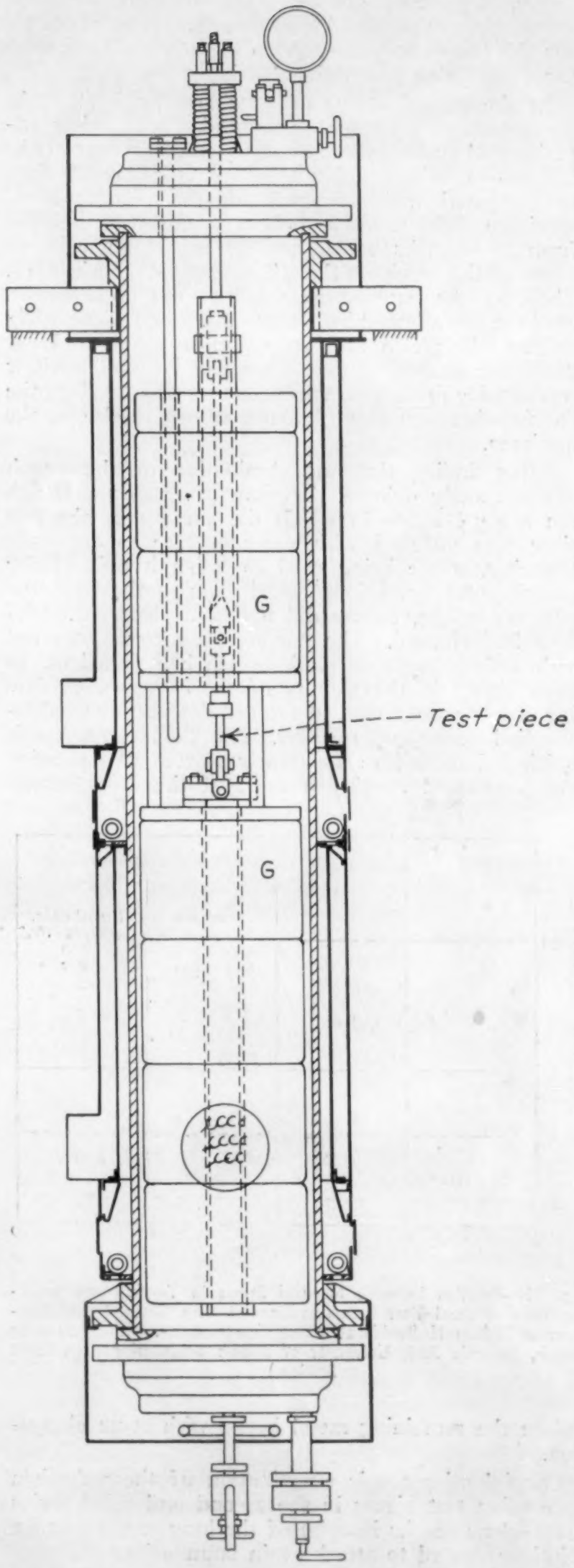

Fig. 13.—Tension Apparatus Used by Ulrich for Embrittlement Tests. Test pieces loaded by weights (G) inside of bomb to avoid friction in packing gland. (From *Mitteilungen 25*, Vereinigung der Grosskesselbesitzer.)

failure. It should also be noted that fine cracks were found developing at the edges of the square test pieces, suggesting the existence of increased local stresses in this region. While there was some tendency for the cracks to follow grain boundaries, they were far from being predominantly intercrystalline.

In the second series of tests run by Ulrich, the specimens were not punch-marked. With other experimental conditions presumably the same as in the first series, failure did not occur until after 28 days as compared with 1.5 days for the punch-marked specimen. The ultimate failure in this case resulted from two cracks which had developed on adjacent edges of the specimen though not opposite each other. These cracks had progressed into the cross-section until the sound metal had eventually failed with clearly evident elongation and reduction in area. Further examination showed that a number of fine, shallow cracks were present on the same two edges and on the flat face between them, but not anywhere else on the specimen.

After finding that the elimination of the punch marks greatly delayed the time of cracking, Ulrich ran a third series in which the surface of the test piece was polished with extreme care to eliminate scratches, rouge being used to finish it off. Under experimental conditions which were otherwise the same as before, failure did not take place until 69.5 days had elapsed. The surface was found covered with a thick layer of oxide which had flaked off to some extent in the vicinity of the fracture. A few fine cracks were found in the metal where the oxidation had penetrated farthest. The single large crack which led to failure apparently started at one edge and penetrated roughly a third of the cross-section

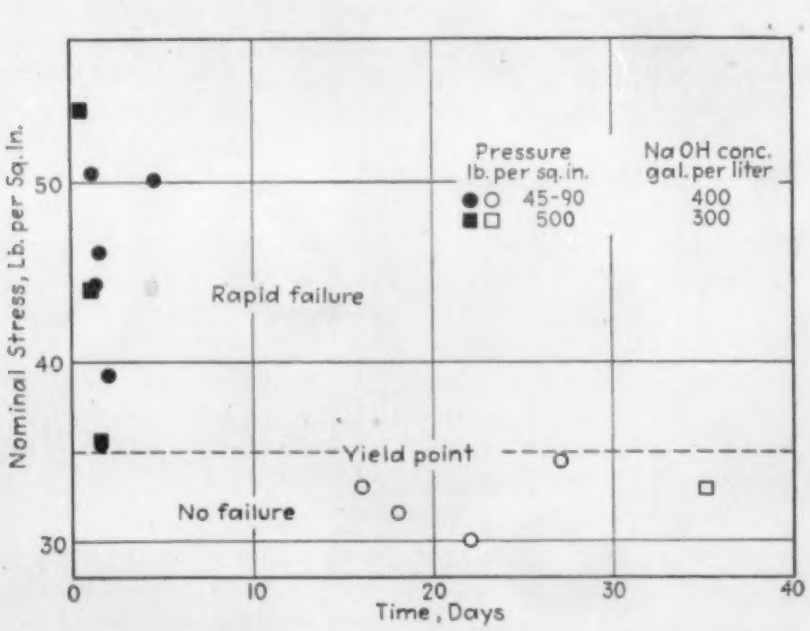

Fig. 14.—Relation between Nominal Stress in Tension and Breaking Time of Steel Test Pieces in Contact with Concentrated Solutions of Sodium Hydroxide at Boiler Temperatures. (From data by Straub, *Bulletin 216,* University of Illinois Engineering Experiment Station.)

before the remaining metal broke with some elongation.

Careful microscopic examination of the unbroken companion test pieces in the second and third series revealed no cracks in spite of the long exposure to a solution reputed to attack grain boundaries.

Considered in the light of the information concerning hydrogen embrittlement presented in a previous section, these observations by Ulrich suggest that such cracks as did develop resulted from the action of high local stresses on steel made brittle by absorption of hydrogen. That hydrogen must have been evolved, the oxide coatings testify, while the superficial cracks perpendicular to the axis of the test pieces in Ulrich's photomicrographs are strikingly similar to those observed by Pfeil[119] in his study of hydrogen embrittlement.

Magnitude of Stress

The load required to break a piece of steel in a short-time tension test, when it is in a brittle condition due to hydrogen absorption, is very nearly the same as the ultimate strength of the metal in its ordinary ductile condition. If the cracks produced in laboratory studies of embrittlement were caused by hydrogen, the stress presumably should have been of this same order of magnitude. Actually, the average stresses reported by Straub as causing failure are much lower. From 10 tests with a concentration of approximately 400 grams of sodium hydroxide per liter at gage pressures between 45 and 90 lb. per sq. in.,[133] a rather sharply defined limiting value of the nominal stress is evident, as shown in Fig. 14. In four of these tests at a nominal stress of 34,400 lb. per sq. in. or less, no failure occurred in periods of from 16 to 27 days; in seven tests when the nominal stress was 35,400 lb. per sq. in. or greater, all of the test pieces failed in from 1.5 to 4.5 days. Similar results were obtained from five tests at a pressure of 500 lb. per sq. in. and a concentration of 300 grams of sodium hydroxide per liter,[134] as indicated in Fig. 14. The steel used in these tests had a room-temperature yield point of 35,200 lb. per sq. in., a fact which may have led Straub to his choice of the stress at the yield point as the minimum necessary to produce an embrittlement failure.

That a stress considerably higher than the yield point may be necessary to cause failure is indicated by data from Ulrich's first series of tests with punch-marked specimens of a steel which had a yield point of 32,600 lb. per sq. in. Although in a solution containing 300 grams of sodium hydroxide per liter and under an average stress of 51,000 lb. per sq. in. two of these punch-marked specimens broke in 1.5 days, other specimens stressed to an average value of 47,000 lb. per sq. in., nearly 45 per cent greater than the yield point, did not fail in 12 days. Indeed, even at the higher average stress of 51,000 lb. per sq. in., two pairs of punch-marked specimens did not fail during 17 days' exposure to a solution containing 330 grams of sodium hydroxide per liter. These average stresses, while far above the room-temperature yield point, were still farther below the ultimate strength at the test temperature, which was approximately 75,000 lb. per sq. in. as determined by the usual short-time tensile test.

These contradictory results cannot be adequately interpreted. Perhaps they may be due to differences in the experimental apparatus employed by the respective investigators, to deviations from axial loading of the test pieces, or to unconsidered changes in the properties of the steel. With respect to the first of these possibilities, Ulrich's method of loading seems more certain than Straub's use of a packing gland on the rod transmitting stress to the test piece.

The question of whether the test pieces in either investigation were axially loaded may be important. Straub used a test piece with a reduced section of rectangular shape having an area of approximately 0.05 sq. in., which was milled out from a strip ap-

proximately 1.25 in. wide and 0.25 in. thick. Holes approximately 0.375 in. in diameter were drilled in the wider ends through which pins were inserted to transmit the stress. Although an effort was made to align the holes properly with the reduced section, this would not have been easy to accomplish. Ulrich used universal joints at each end of and between his companion specimens, the latter being screwed into the former. However, the test pieces were apparently machined in the form of flat strips, so that the threads on the relatively narrow edges of the ends met the threads of the fittings into which they were screwed only over a small fraction of the circumference of the latter. Any looseness in the fit would accordingly have permitted a slight displacement of the test piece to one side of the load axis. Great care in milling the reduced section would also have been necessary to insure axial loading. From the definite limitation of the cracks in the second series to one face and the adjacent edges of the test piece it seems possible that a slight bending moment may actually have been present. In either Straub's or Ulrich's investigations eccentric loading at room temperature would probably have produced a definite bend in the test piece, with some redistribution of the load on the cross-section of the metal. Residual local stresses above the average value would presumably have been left in the surface of the metal.

Any interpretation of the tension tests of Straub and Ulrich must take into account probable changes in the steel during testing. Initial loads above the yield point must have cold-worked the test pieces, with accompanying reduction in area, before they were exposed to chemical attack. When heated to the test temperature, they would then undergo accelerated aging, with an increase in tensile strength and decrease in ductility. During the test, the continuous general reaction of the steel with the solution would be evolving hydrogen and building up a coating of iron oxide, with a corresponding reduction in the cross-sectional area of sound metal. At the higher temperatures, a long time of exposure, as in Ulrich's tests, might lead to the decrease in tensile strength and corresponding increase in ductility, which represent a later stage of the aging process.

No conclusion concerning the stress necessary to cause embrittlement failure seems possible on the basis of the available data. Further study of the question would be expected to throw some light on the mechanism of failure.

Temperature

Although in itself pressure is probably an insignificant variable in the embrittlement process as compared with temperature, all of the results of Straub and Ulrich were referred to a pressure basis. This renders comparison somewhat difficult because the pressure-temperature relationships of sodium hydroxide solutions change with concentration and the necessary data for interconversion are not available. Furthermore, the pressure in a bomb is due not only to water vapor, but also to the formation of hydrogen by the reaction between iron and water. As has been noted in the first part of the report, this hydrogen pressure may reach a very considerable value. As a result, two bombs maintained at the same approximate pressure may differ in temperature by a really important amount.

In general, increase in temperature would be expected to accelerate whatever chemical processes may be involved in the embrittlement failure of steel. That this is true has been indicated by three of Straub's tests run in solutions containing 200 grams of sodium hydroxide per liter. At pressures of 100, 500 and 1000 lb. per sq. in., respectively, and under an unstated stress, which presumably had the same average value in all cases, his specimens broke in 720, 30 and 10 hrs.[135]

The same trend may be deduced from two series of tests run at different concentrations of sodium hydroxide at 100 and 500 lb. per sq. in. gage pressure under a high average stress of 54,000 lb. per sq. in.[136] At corresponding concentrations the test pieces failed in a much shorter time at the higher pressure and temperature. To what extent aging and the continuous general conversion of the steel into oxide, as previously noted, may have affected these results cannot be determined, but increase in temperature would be expected to increase the rate of the chemical reaction and to accelerate the aging process.

Solution Composition

The data of Straub just quoted also indicate that at each pressure (temperature) the life of a test piece became progressively longer as the concentration of sodium hydroxide was lowered. The lowest concentration which actually resulted in failure of a test piece was 115 grams per liter. Straub came to the conclusion that cracking might be produced at a concentration as low as 100 grams of sodium hydroxide per liter.

When different amounts of sodium chloride were added to a solution containing 300 grams of sodium hydroxide per liter for tests under some unspecified stress at 500 lb. pressure,[137] the breaking time varied between 7 and 24 hrs. In view of the unavoidable uncertainties in the method of testing, the differences are scarcely significant.

Various substances added in relatively low concentration were found by Straub to have a marked inhibiting effect upon embrittlement failure. In a series of tests at 500 lb. pressure with a sodium hydroxide concentration of about 285 grams per liter and an average stress of 45,000 lb. per sq. in., he found that the following concentrations of added substances or radicals prevented cracking: PO_4, 0.6; CrO_4, 2.0; NO_3, 4; sodium acetate, 75; tannic acid, 10; and As_2O_3, 30 grams per liter. From the discussion in the first part of this report, these added substances might be expected to assist in the maintenance of a relatively impervious coating on the surface of the steel.

Sodium sulphate in solution would also be expected to exert a protective effect against the attack of concentrations of sodium hydroxide up to approximately 50 grams per liter.[138] Straub's investigations over a higher range of concentrations led him to the conclusion that sodium sulphate inhibited embrittlement only as a result of its deposition as a solid in contact with the steel. In a series of preliminary experiments at lower pressures with test pieces stressed to a nominal value of 40,000 lb. per sq. in. in contact with solutions containing from 365 to 500 grams of sodium hydroxide and various concentrations of sodium sulphate, he found that the time of breaking increased only from 6.5 to 10.5 days with increase in the $Na_2SO_4/NaOH$ ratio from 1.2 to 1.8, but no break was obtained in 41 days when the ratio was 2.1. In similar experiments with sodium carbonate added as an inhibitor, he found that an increase in the $Na_2CO_3/NaOH$ ratio from 0 to 0.7 increased the time of breaking from 2.5 to 11 days, while a ratio of 1.5 resulted in

no break in 40 days. When the bombs were opened at the end of these tests the added salts were found to have crystallized on the test pieces.

In later tests[139] Straub found that saturation of a sodium hydroxide solution with sodium sulphate did not prevent cracking, but that when loose crystals of sodium sulphate surrounded the test piece it resisted failure. Unfortunately, no experimental data are given to allow comparison and interpretation.

The suggestion that the apparent ability of sodium sulphate to prevent embrittlement might be due to a mechanical plugging of the small spaces in riveted seams during extreme concentration of boiler water therein has been made from time to time.[140, 141] Straub, however, has expressed the opinion that the solid salt crystallizing on the surface of the metal lowers the potential of the metal with respect to the solution and thus prevents chemical attack.[142] This theory does not seem correct, since the actual potential difference between steel and a solution of sodium hydroxide saturated with sodium sulphate should be the same whether the excess of solid sodium sulphate was in contact with the steel or at a considerable distance from it. A clearer insight into the mechanism by which sodium sulphate may retard embrittlement is much needed.

Type of Steel

One possible means of obviating embrittlement would be to use a specially resistant steel. In an endeavor to discover whether such a material existed, Straub tested 33 different samples ranging from Armco iron to high-chromium steel.[143] The only material which did not crack was a chromium iron with a chromium content of 12 per cent and very little or no nickel. Austenitic stainless steel of the 18 chromium-8 nickel type seemed particularly susceptible to cracking.

Conflicting claims have been made concerning the resistance to embrittlement of the special German steel called Izett. Fry[144] has presented tests to show that Izett, which is a non-aging steel, does not crack when exposed to caustic solutions under conditions which cause the failure of ordinary steel. On the other hand, Straub[145] found that Izett failed as readily as standard flange steel under his test conditions. Ulrich[132] in turn has supported Fry's statement by tests in which samples of Izett and an American flange steel were exposed under comparable conditions. These tests were presumably run at 35 atmospheres pressure in solutions containing about 285 grams of sodium hydroxide per liter. Punch-marked specimens of his first series showed no failure for Izett steel in 20 days under an average stress which was 82 per cent of the room-temperature tensile strength, as against failure in 1.5 days for the flange steel. Test pieces of the second series with an ordinary finish and without punch marks likewise resulted in no failure in 56 days for Izett steel stressed to 85 per cent of its room-temperature tensile strength, while the flange steel failed in 28 days. In the third series of tests with test pieces polished with rouge, the Izett specimen was stressed to 90 per cent of its room-temperature tensile strength, which, because of the fact that a non-aging steel shows a decreasing strength with increasing temperature, was 97 per cent of the tensile strength at 480 deg. F. (250 deg. C.) approximately the test temperature. This piece at the end of 52 days, during which there had been some interruptions, had not failed, but had elongated 20 per cent and was necked down so much at one point that failure was imminent. The comparison specimen of flange steel failed in a brittle manner after 69.5 days.

In no case did microscopic examination of the specimens of Izett steel after exposure show any cracks.

The apparent contradiction between the results of Straub on one hand and those of Ulrich on the other demands further investigation of the behavior of non-aging steels under combined stress and chemical attack.

Conclusions

From the large number of more or less contradictory details mentioned in the preceding sections, certain important generalizations may be derived:

1. The cracking of steel subjected to chemical attack while under stress consistently commences in a region where the local stress is greater than the average.

2. An unknown but probably very high local stress is necessary to initiate cracking.

3. The yield point at room temperature is not a fundamental criterion of the stress necessary to cause cracking.

4. No definite experimental evidence has been produced to show whether embrittlement failure is due to intercrystalline corrosion, to the action of high local stresses on steel made brittle by hydrogen, or to some other type of action.

5. Most steels are subject to embrittlement, although there is some question concerning a possible greater resistance in the case of non-aging steel.

(To be continued)

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The Non-Ferrous Mining and Metallurgical Industry in Spain

By DR. E. JIMENO* and F. R. MORRALt

TO PRESENT A COMPLETE report of the non-ferrous industry in Spain is a difficult task. The Spanish State is not able to furnish accurate statistics, since in the matter of inspection there exists duality of interest. (Real orden de Marzo 1, 1928.) Thus, when the inspector of mines desires to inspect a mine, the proprietor declares it under the Department of Public Works; and, when this inspector presents himself, it is declared under the jurisdiction of mines. Thus, valuable data are lost for the annual report. To this is to be added the fact that the State knows of the unwillingness of the industrialists to pay the high taxes it exacts, and so it makes stiff laws. The industrialists, on the other hand, use all their wits to get around them. The statistics suffer again by showing lower returns than the actual ones.

The social situation has also played an important role recently, although the extent cannot be calculated up to this time because of the lack of monthly statistics such as may be obtained in other countries.

The Mining Council of Spain has published recently a "Mining and Metallurgical Report for Spain" for 1933. This study covers 692 pages showing the available statistical data for mining, the manufactured products derived therefrom, water resources, etc., and the changes observed by the inspectors in their respective zones.

totals about $21,800,000. As an appendix we find the production of minerals in comparison with 1924 and 1928 when Spanish mining enjoyed its most prosperous activity.

Gold, Tin and Bismuth

To be noted is the advance made in this 10-yr. period in gold and tin mining. The total for tin is certainly low. In general the mining of non-ferrous minerals has decreased. The tonnage for bismuth is surely low since in Cordoba, where it is mined, there are many mines exploited by the owners and employees who, distrustful of each other and aspiring to social and financial position, do not get together so as to work under technical direction and with the necessary methods which would benefit them. If properly exploited, this region should be a factor in the world market for bismuth.

The reports of the inspectors show that, in spite of the depression, some improvements have been made in mines and plants, some of which are as follows: In 1934 a tin ore reduction plant in Coruña installed concentrating apparatus so as to use a method of flotation. This is, probably, the first and only Spanish company which has taken such a step up to the present time. Some companies have made improvements, such as mechanizing their means of transport, although most of the improvements have been of a social nature, such as establishing obligatory accident insurance, organizing cooperatives, houses for the workers, hospitals with the latest equipment, and so on.

It may be of interest to recount what has happened in Murcia. In the last year the accident insurance company records a larger number of patients who,

(Continued on page 321)

Table of the Non-ferrous Mining and Metallurgical Industry in Spain*

	MINING, 1933				METALLURGY, 1933					Percentage of Output in	
Metal	No. of Mines	No. of Workers	Production, Tons	Value in Thousand Pesetas	No. of Plants	No. of Workers	Production, Tons	Value in Thousand Pesetas	Efficiency in Per Cent	1924	1928
Bi	4	86	77	384	2	10	26	390	34	61	60
Zn	7	1,344	94,537	12,758	2	606	8,548	6,003	9	81	77
Cu[1]	..	....	49,537	96	..	....	....	....	....	17	14
Cu[2]	2	489	646,971	14,444	..	6,152	35,301	39,719	5	65	18
Sn	7	300	262	465	..	....	....	....	....	1,090	58
Mn	4	78	2,834	93	..	....	....	....	....	....	....
Au	1	250	18,241	91	1	....	0.24	1,920	0.0085	7.560	....
Pb[1]	99	7,364	114,528	21,755	..	....	88,354	37,050	77	73	82
W	1	26	42	73	..	....	....	....	....	21	22
Hg	3	1,233	10,137	1,587	1	450	677	9,810	43	68	21
Al	..	....	....	....	1	110	1,154	5,186	....	....	....
Sb	..	....	....	....	..	....	83	124	....	....	....
Ag	..	....	....	....	..	....	9,112	9,303	....	....	....
Brass	..	....	....	....	..	....	304	620	....	....	....
Pb[3]	..	....	....	....	..	....	570	664	....	....	....
Totals	128	11,170	937,166	49,746	7	7,328	141,129	110,789			

[1] Mineral. [2] Ferropirita. [3] Minimum of lead.
* Taken from the Report of the Council of Mining of Spain.

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Some Problems in the Manufacture of Southern Merchant Pig Iron

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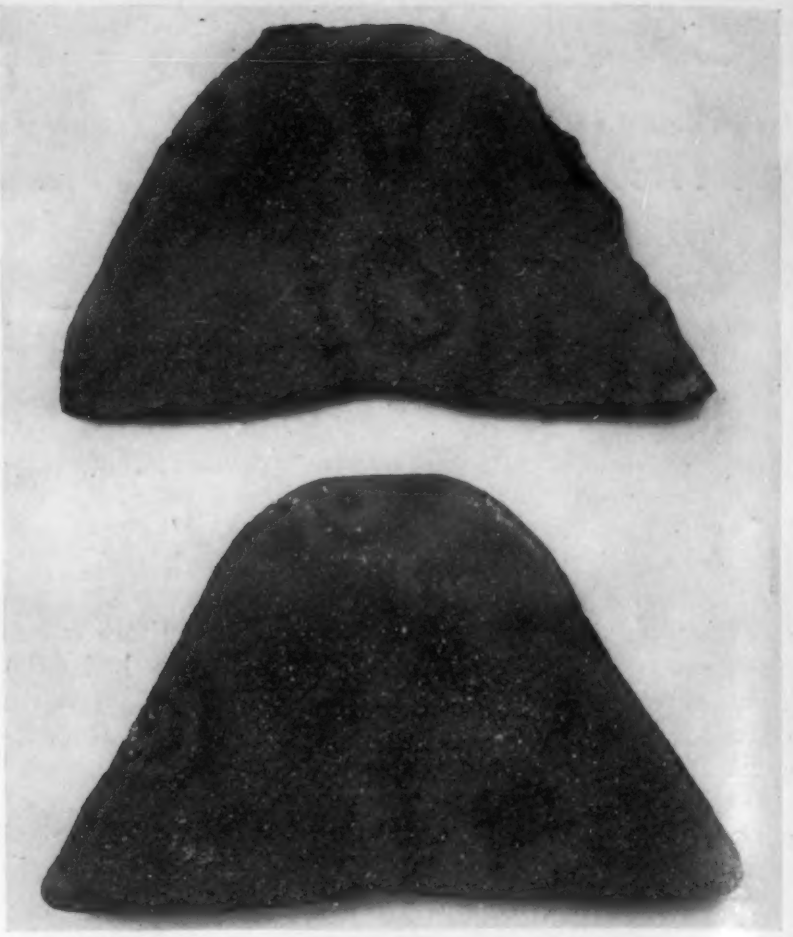


Sections of Slow Cooled Machine Cast Iron. Note the open grain and absence of chill.

As recently as ten years ago it was customary for the Southern blast furnace operator to burden his furnace with Red Mountain hard ore and dolomite and proceed to make pig iron. Some local brown ore was used from time to time, but little attention was paid to the effect of this on analysis. The result was that the iron sold was pig iron, but little else could be said for it. Silicon and sulphur content varied greatly, the phosphorus was usually high (about 0.85%), and the manganese ranged from 0.35 to 0.90 per cent (but usually close to 0.40%).

In competition with him was the northern manufacturer who was, and still is, blessed with ores which automatically give him a more popular iron. His phosphorus will run as low as 0.12 to 0.18 per cent, and he will normally have a manganese content of 1.25 to 1.40 per cent without manganese ore additions. Most of the northern iron was already machine cast as opposed to the southern sand cast, which gave the northerner a decided advantage among progressive melters who desired a clean iron of good chemical properties.

Under the leadership of progressive furnacemen and aided by increased knowledge by the melters, this picture has changed, at first slowly and recently quite rapidly. The depression, with its attendant lack of volume of business, caused more and more stress to be placed upon quality. It became necessary for the melters to know more and more of the metallurgy of their product, and hence demanded iron of closer specifications. Furnacemen had to meet this demand, and, in view of the hard competition, were forced to keep ahead of the customer's wants. This, of course, has been true of all business, and is largely responsible for the great technological advances of the past few years. Recent changes in the Code have emphasized this in the iron business, so that it is now necessary to make a high quality product if you are to sell anything at all. [Although the code has been nullified its provisions are still being observed.]

In addition to the depression's emphasis on quality, it also caused a close watch on cost, with the result that more and more scrap was used by the melter. This not only interfered with the pig iron market, but also created the demand from furnacemen of iron which contained the proper elements to make up for the deficiencies of the scrap, and also a closer control of the entire chemical content. A glance at the changes in standard specifications in the past few years will emphasize this problem.

Old and New Sulphur and Silicon Specifications

Until the fall of 1933 iron was graded by silicon *and* sulphur content. Fifty points was the range for silicon and the grades were usually called by name—a hangover from the old method of classification by fracture. Thus, iron with sulphur under 0.050 per cent and with silicon from 1.75 to 2.25 per cent was called No. 2 Foundry Grade, while silicon from 2.25 to 2.75 per cent was called No. 2 Soft, etc.

Although 0.050 per cent sulphur was the division point for good grade iron, there were several grades in which the furnaceman could dispose of his high sulphur iron. No. 3 Foundry was iron with silicon 1.50 per cent and up, and sulphur 0.050 to 0.070 per cent; No. 4 Foundry was silicon 1.25 per cent and up, and sulphur 0.070 to 0.090 per cent; and Gray Forge was silicon 1.00 per cent and up, with sulphur 0.090 to 0.10 per cent. There was also a "mottled" classification for iron worse than gray forge.

We no longer have No. 3 and No. 4 Foundry and Gray Forge to take care of high sulphur iron, but are limited to 0.050 per cent sulphur in all commercial grades. Whereas before it was satisfactory to aim for close to the limit, knowing that if you went a little over you still had salable iron, it is now neces-

sary to keep the sulphur in the 0.020's and low 0.030's so that an unexpected jump (due, perhaps, to a burned tuyere letting water in the furnace) will not throw your furnace off grade. The result is that customers are now usually getting iron of much better sulphur content than the maximum specification, and, since they usually get it, they expect it as regular practice. Therefore, much closer control over sulphur is now necessary than ever before.

Very close watch must also be made on silicon content. Since this is the determining factor as far as grades are concerned, it is essential that the silicon be held in a close range in order that the desired grades will be produced. This requires a very uniform furnace operation and careful checking of the chemical analysis. Keeping the furnace on proper grade is at present the most important problem facing the operator.

Phosphorus and Manganese Requirements Changed

The change in demand for phosphorus and manganese has been developing more slowly, but it has now reached the point where it is a very definite factor. Pressure pipe manufacturers and others are forced to meet Federal specifications which call for certain transverse tests, tensile strength, and close check on Brinell hardness. Gray iron foundries have met this by the use of scrap, (such as rail scrap), to lower the phosphorus in order to get the proper tensile, etc. This competition has forced the southern furnaceman to lower the phosphorus in his iron, which was necessarily done at great cost due to the use of more expensive ores.

The control necessary to fill orders properly at present may be appreciated by studying the requirements of four large melters. All of this iron is 2.00 to 2.25 per cent silicon and 0.050 per cent maximum sulphur and is of standard grade, carrying no premium:

Customer No.	Phosphorous Per Cent	Manganese Per Cent
1	0.90	0.30 Max.
2	0.75 Max.	0.45 Max.
3	0.90	0.75
4	0.75 Max.	0.75

From the above it is seen that Customer No. 1 is the only one whose requirements can be approached by using straight Southern hard ore, and this is an unusual specification in comparison with the normal iron that is now shipped. There are also a great many specifications which command a premium price, and which demand very close metallurgical control.

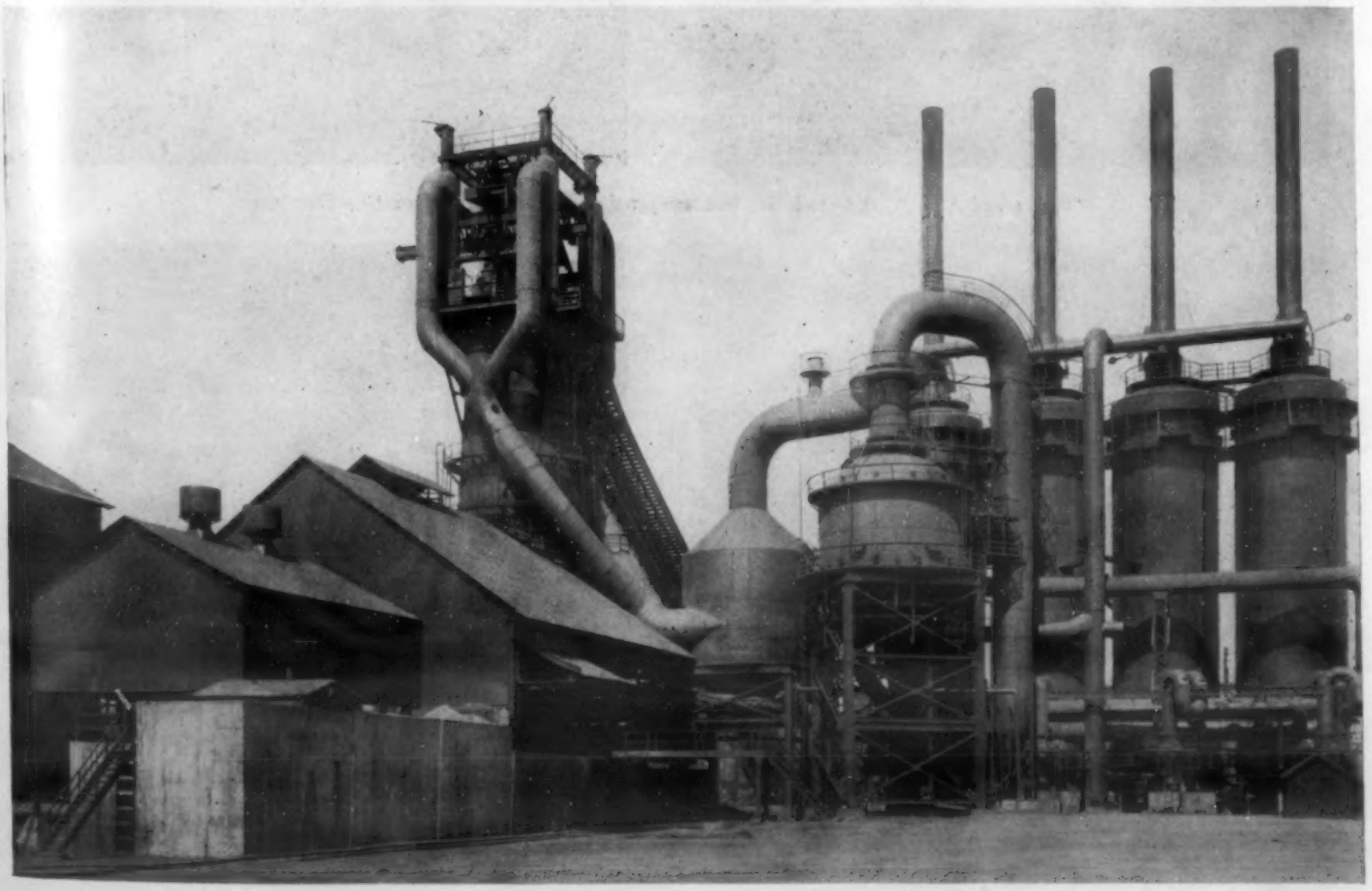
In addition to the various specifications for foundry and basic iron we must also be prepared to make speigel, 60 and 80 per cent ferromanganese, and 15 per cent ferrosilicon.

Raw Material and Furnace Control Important

Thus the merchant furnaceman can no longer aim for production only and let the grades fall where they may, for production no longer means "how much iron," but "how much *good* iron." His problem approaches that of the open-hearth operator, and he is finding the answer not through ladle additions, etc., but through strict control of the furnace proper and careful selection of raw materials.

This requires a thorough knowledge of many factors. Of prime importance is the chemical analysis of the raw materials. The hard ores in the Birmingham district are usually quite uniform from a given mine (but vary considerably in lime and silica in different mines). Brown ore, which is used to lower the phosphorus and as a cheap source of manganese,

A Recently Remodeled Republic Steel Corp. Blast Furnace at Birmingham. The furnace was increased in height, the stock line enlarged, and improved off-takes and downcomers installed.



varies considerably. It is, therefore, necessary to know the nature of all the deposits that are being used. Each car must be analyzed separately. A sample taken from the top only will not give a true picture of the content of the car, so all cars should be sampled in cross section as they are unloaded. Cars with unusually high insoluble must be handled very carefully in order that the acid-base ratio of the slag will not be upset with consequent production of high sulphur iron.

The refractory quality of the ore is also an important factor. Brown ore is much easier to reduce in the furnace than hard ore, and different hard ores vary from each other in this respect. This must be considered in burdening the furnace, for if a highly refractory ore is substituted for a low one, pound for pound, even though the chemical analysis was the same, the result would be a colder furnace and hence lower silicon.

The nature of the coke is of prime importance and its effect is felt in several different ways. First, variation in the ash means variation in the fixed carbon, and this in turn means variation in the heat supplied to the furnace. Since heat is the means of control for silicon, a change in the coke ash means a change in the silicon, even if all other factors are kept uniform. Second, size of coke: Most furnaces measure coke by volume, and since smaller coke weighs more per unit of volume a change in the size means a change in the weight of coke, which again means a change in the silicon. In this connection, the amount of wind blown must also be considered, for a small coke will give more satisfactory results on low wind than it will on high wind.

The effect of porosity on the melting zone and of other physical characteristics of the coke on the general operation of the furnace are other factors which must be considered constantly.

The proper hot blast temperature and proper amount of wind for good working of the furnace must not be overlooked. High blast heats are desired in order to reduce coke consumption but, if they are carried too high, trouble sometimes results, causing the furnace to hang or blow through. Hence proper furnace control depends to a large extent upon the human factor and it is necessary to have competent blowers and stovemen who must watch their furnaces very closely.

Increased labor costs due to Code requirements have taken away one advantage the Southerner has had until now. This is felt not only in the direct conversion cost, but also in the cost of ores and other materials. High flue dust loss has until recently been pretty well ignored, due to the low cost of good ore, but this can no longer be done. Furnaces, therefore must be built and operated to control the dust loss as well as to control grades. This is being done by increasing the stock line until it is as large or larger than the hearth, installing improved gas offtakes and downcomers, using sized ore and coke, careful regulation of tuyere size and wind volume, etc.

Physical Appearance An Important Factor

Another aspect of merchant iron making of equal importance to the chemical control is the physical appearance. Our company has been a pioneer in this respect. If a melter expects to make presentable castings, he needs presentable iron to start with. As recently as 1929 the majority of Southern merchant iron was sand cast. Machine cast iron is, of course, better for several reasons:

1.—The analysis is more uniform per cast, due to the iron being held for a while in the ladle, giving a mixing effect.

2.—Absence of adhering sand makes the weight of actual iron higher per ton of product bought.

3.—Iron is cleaner on account of skimming.

4.—Size of pigs is more uniform and "sows" and "jumpers" are eliminated.

"Before and After." Old sand cast iron compared with modern clean machine cast iron.

The first stage in the development was the introduction of "Triple Skimming." This means that slag, kish, and other foreign particles are skimmed from the iron three times before the iron reaches the mold with the result that the majority of the impurities are removed before the iron reaches the mold. The effect of this is a pig that looks like a high grade casting.

ameling is to be placed on the casting, are now buying iron by both chemical analysis and fracture. It has been found in this type of work that chemical analysis is an insufficient guide and that the iron must have the proper fracture as well. This is a field that is just opening up, and we shall probably learn much of the importance of proper fracture ere long.

Other features in the pig machine operation are

Certain foundrymen did not like machine cast iron because the fracture was different from what they were accustomed to. A method of cooling the iron at the pig machine was therefore developed which allowed the iron to cool more slowly and hence assume its more normal fracture. This also has the advantage of making the pig less brittle, so that it does not break as it strikes the car, which is also a factor in improved appearance and elimination of "bleeders."

An interesting sidelight to this is the fact that certain large melters, especially where a vitreous enamel is to be placed on the casting, are now buying iron by both chemical analysis and fracture. It has been found in this type of work that chemical analysis is an insufficient guide and that the iron must have the proper fracture as well. This is a field that is just opening up, and we shall probably learn much of the importance of proper fracture ere long.

Thus it is seen that merchant pig iron production in the South is no longer a rule of thumb proposition. New problems of cost, sales and advancing metallurgy are constantly being presented. Their solution will be found through close cooperation of all concerned, to the benefit of all industry.

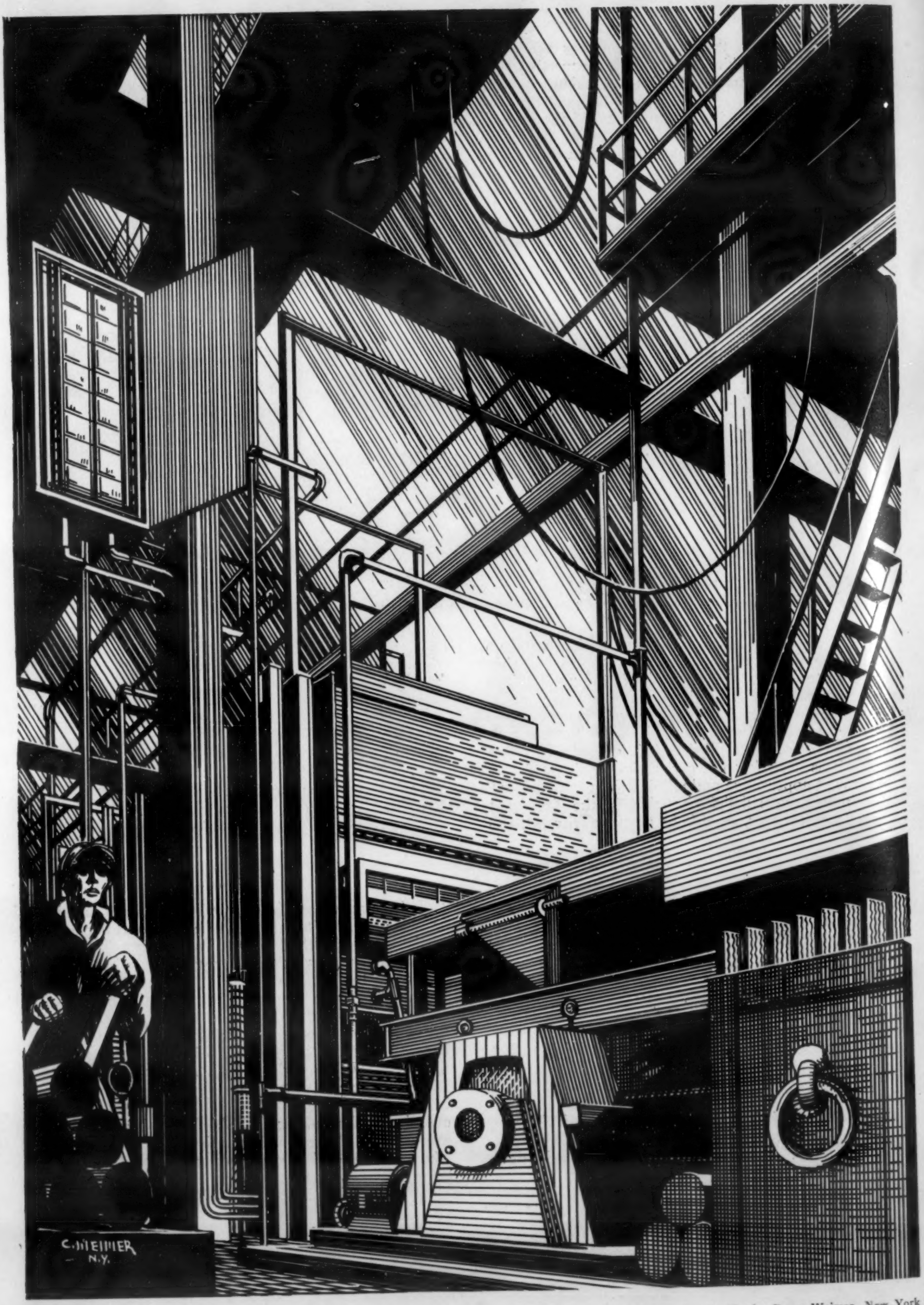
(Continued from page 317)

while on the patient list, are paid, holidays included. While working they are paid only while on the job, and although they get much higher salaries than formerly, they do not get the gratification they used to. The expenses for the industry have increased while the actual accomplishment of the worker has decreased. In 1933 there were two important strikes in this same region, and this was the minimum for most of the regions in Spain.

Institute of Metallurgy Organized

An Institute of Metallurgy and Mechanical Construction has been recently organized in Barcelona (March, 1935). Its object is to extend scientific, technical and economic knowledge to certain industries in Spain. It will attempt to obtain more complete statistics of manufacture and usual methods of fabrication in non-ferrous metallurgy.

The Council of Mining, already mentioned, has recently offered a program to the Spanish government to aid the mining industry. It asks for an expenditure of 16 million pesetas ($2,100,000) for prospecting and investigating the natural mineral resources of the nation, and for 84 million pesetas ($11,100,000) which are estimated as necessary for preparation and beneficiation. Thus 30,000 workers should find occupation. New mines of gold, lead, silver and other minerals, capable of exploitation, are to be sought. The mines now being worked are near their end.



From a drawing by Charles Perry Weimer, New York

Controlled Atmospheres in Steel Treating—IV

A Correlated Abstract

By H. W. GILLETT

Editorial Director of METALS & ALLOYS *and Chief Technical Advisor, Battelle Memorial Institute, Columbus, Ohio.*

THIS COMPREHENSIVE CORRELATED abstract is discussed in four parts: Part I was largely introductory, dealing with the character of the usable gases. Part II dealt with the cost and action of different usable gases. In the August issue all of Part I and a portion of Part II were published. In the September issue the remainder of Part II and all of Part III—"Furnaces in Which to Apply Controlled Atmospheres"—were published. Part IV, which has as its title "Correlation of Experiments and Experiences," was published in part in the October issue and the series is concluded in this, the November, number.—EDITOR.

Part IV—Correlation of Experiments and Experiences

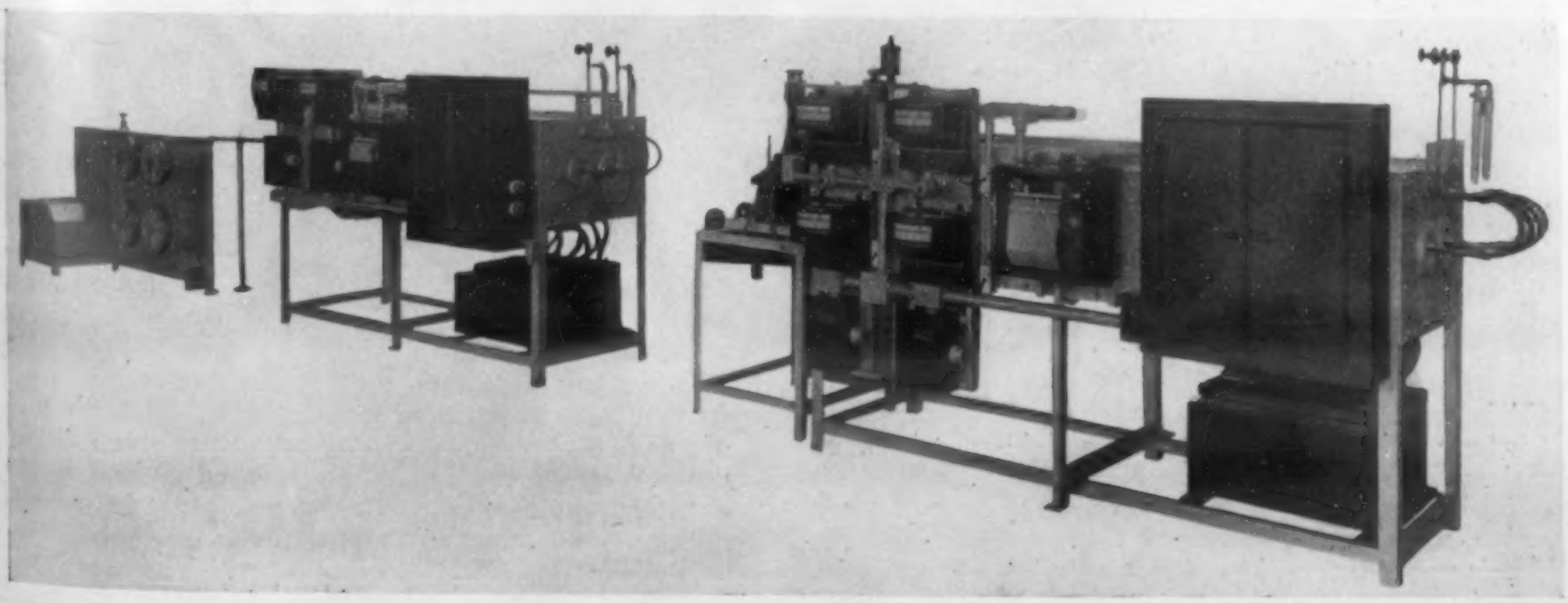
Bright Annealing of Sheet and Strip

The bright annealing of low-carbon sheet and strip is differentiated from the cases mentioned above, because the temperature is down in the ferrite range, say 1200 to 1250 deg. F., where carburization is practically inhibited and decarburization proceeds but slowly. A prime aim is to avoid scaling or staining, and since the work is cooled down in the special atmosphere in box annealing, or passes into a cooler zone in a continuous process, the low-temperature oxidation propensities of water vapor have to be guarded against.

In box annealing in closed (sand sealed) boxes, it is considered that the oxygen of the air produces a thin scale on heating up, and that when the annealing temperature is reached this reacts with the carbon in the steel, "clearing" the scale. As the air initially in the box expands it is forced out through the sand seal. In cooling, air will again be drawn in, and will reoxidize the steel, so at this stage a gas is introduced to keep the air out and aid in the more complete reduction of the scale. This naturally results in a slightly decarburized surface. Displacing the air at the start is therefore employed when decarburization is to be avoided.

The leading-in of city or natural gas, either raw or

Fig. 41.—Controlled Atmosphere Furnaces, electrically heated, for Hardening and Tempering Strip Stock, as for Razor Blades, etc. Each furnace has two chambers, independently controlled. Gages for regulation of the controlled atmosphere are shown at the inlet end. The tempering furnace, as well as the hardening furnace, may be supplied with a controlled atmosphere so that either a bright or an intentionally blued product may be obtained. "Falcon" furnaces made by H. O. Swoboda, Inc.



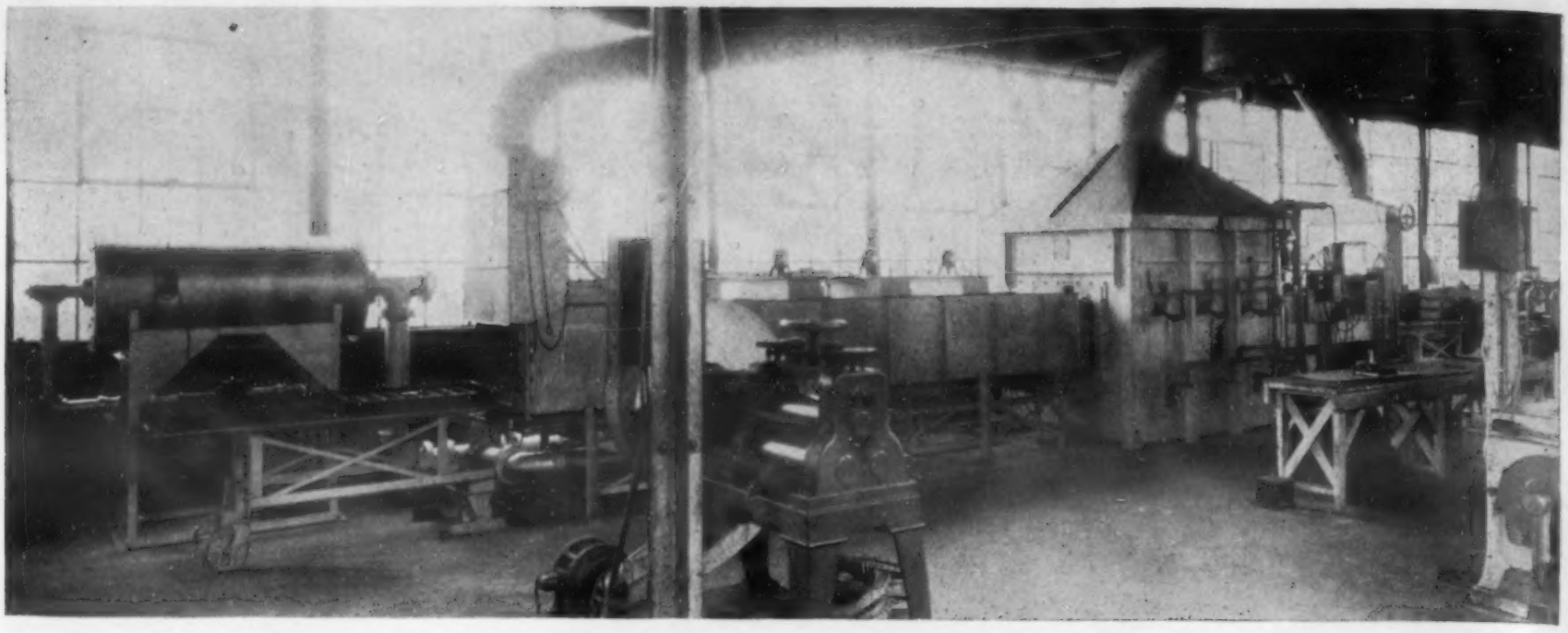


Fig. 42.—Pusher Type Bright Annealing Furnace, Gas-Fired. Partly burnt gas for the controlled atmosphere is generated by the equipment at the left. The final cooling chamber is provided with fans for hastening the rate of cooling. W. S. Rockwell Co.

after passing through hot charcoal and iron filings, into standard annealing boxes is very old, but is seldom considered entirely satisfactory on account of likelihood of soot deposition. One analysis of a gas, passed in during the cooling cycle for bright annealing and made from city gas by passing it over heated coke, was 50 per cent H_2, 25 per cent CH_4, 10 per cent CO, and 2 per cent CO_2. Some etching was encountered with this atmosphere.

More recently a partly burnt natural gas atmosphere, produced in some one of the commercial "forming" units has been applied, either in the old type externally heated thick boxes, or in special "annealing covers" thin sheet steel boxes, refractory lined, provided with diffusion-burner "radiant tubes" and a thin inner cover over the sheets themselves. The low operating temperature should insure good life for the tubes. It is possible to hasten cooling by passing air through the tubes. The desired atmosphere of partly burnt gas is brought inside the inner cover. One such gas analyses 10 per cent H_2, 5 per cent CO, 6 per cent CO_2, and 1 per cent CH_4. Discussion rages as to whether one should have some appreciable H_2O content in the atmosphere, as Marshall[38] advocates, and balance it, or remove the moisture almost completely.

Then there are the advocates of N_2-H_2 mixtures for such work, with rather convincing arguments.

According to Austin[17], the atmosphere should be "not more than slightly carburizing," though for some uses it would not seem that a little carburization would be harmful.

The desirability of avoiding pickling, or of reducing it and other cleaning processes before applying coatings of various kinds, indicates that continued study will be given to the bright annealing problem. The requirements as to surface finish and requirements as to freedom from decarburization would have to be very definitely stated before one could eliminate all inoperable types of atmospheres.

Gas Carburizing

IT is something of a relief to turn from the cases where it is necessary to walk a tight-rope between carburizing and decarburizing effects and deal with conditions where we can operate so as to have just one action, a definitely carburizing one.

It is generally considered that even in pack carburizing the real cementation comes from the action of CO in the gas phase. But for actual gas carburizing, CO alone is too weak a carburizer and hydrocarbon gases are used, these can be considered as essentially CH_4 because the higher hydrocarbons tend to break down to CH_4 and H_2. Hence the CH_4 must be in sufficient amount to suppress the decarburizing effect of H_2 as shown by the left hand curve of Fig. 13.

Natural gas, city gas, propane, butane and oil gas are all used for carburizing. A low sulphur gas is essential.

When any of these are led into a hot furnace without air there will be soot deposition and freeing of hydrogen and a small amount of unsaturated hydrocarbons. As the rate of production of unsaturated hydrocarbons is affected by small changes in pressure, etc., greater constancy of gas composition is effected by burning them as fast as they form by adding air. This involves consideration of the CO_2:CO, and H_2O :H2 equilibria as well as that of CH_4:H_2.

The CO_2 and H_2O seem to have a real function, beyond that of securing a less variable atmosphere, for succesful gas carburizing is done with a sufficient amount of crackable hydrocarbon to produce a soot film on the work and with enough CO_2 or H_2O to give a very slight tendency toward a transient oxidizing reaction so that the proper catalytic action will take place at the steel surface. The atmosphere control in this case is exerted to hasten the rate of carburizing, the carbon content of the case, and, by adjusting the rate of carburizing against the rate of carbon diffusion, to secure a smooth gradation from case to core rather than a sharp dividing line.

Discussion of these important phases of the carburizing problem is outside the scope of this review. Some operators intentionally produce fluctuations in the atmosphere, feeding in gas for a time and then shutting it off so that diffusion may allow excessive higher eutectoid carbon at the surface to diffuse toward the core during the period when the gas is cut off.

Other operators consider that any fluctuation in gas feed or gas composition is undesirable. Rate of flow of gas is a very important factor. Excessive soot deposition on the work may be prevented by heating the incoming gas to the operating temperature before admitting it, so that the most of the excess soot is deposited outside the furnace proper. The work can

usually be packed so that those parts which must be bright and clean are furthest from the incoming gas and free from soot, while those that are to be ground all over are placed so they receive the soot. Too thick a carbon coating prevents proper contact of gas and work, thus producing irregular carburizing.

Behavior of City Gas

Guthrie and Wozasek[81] discuss the behavior of city gas of various compositions for carburizing, finding it necessary to control the moisture content to secure consistent results. A little moisture was necessary to get rapid carburization. Most gas carburization is done with gases of more constant composition than average city gas. Hence natural gas, propane and butane are much used.

Giolitti [47] has discussed CO, Sykes [82] CH_4 and Lindberg[83] oil vapor. J. A. Dow (personal communication) doubts that CH_4 is an effective carburizer. He ran carburizing tests in an atmosphere of 25 per cent CH_4, balance CO, H_2 and N_2 (CO_2 and H_2O were removed). The gas came through the carburizing retort but little changed in methane content, no soot was formed, and only a slight case was produced. Hence he concludes that in the experiments of Sykes, it was the ethane content, considered by Sykes to be a diluent, that was chiefly responsible for carburizing. Wilbur and Comstock[84] find that any hydrocarbon gas can be used for carburization even though it may deposit large quantities of soot, if a surge of CO_2 is periodically admitted to clear away the excess soot. They also studied the dilution of city gas with flue gas. In discussion Osterman advocated propane diluted with air.

On the other hand one authority reports that a mixture of 2 parts air to 1 part propane gas was unsatisfactory and that a mixture of 20 parts coke oven gas with 1 part propane gas is the most satisfactory. Cowan[85] advocated partly burnt gas mixed with CH_4 to maintain a definite CH_4:CO_2 ratio.

In an early installation of controlled atmosphere in batch carburizing by mixing partly burnt gas and raw natural gas it was found that hunting of the regulators, producing a variable atmosphere, gave poor carburizing and that the composition must be held constant.

Another instance of batch type carburizing is with partly burnt gas made in one unit, its water vapor being removed by refrigeration, plus partly cracked natural gas, plus some raw natural gas. The proportions of gas and air must be controlled, the cracking rate and temperature must be controlled and finally the proportions of the three gases, partly burnt gas, partly cracked gas, and raw gas, must all be regulated. It is reported that, when this outfit did work, the results were fine but it took a laboratory man to run it.

There is another complication in carburizing in a controlled atmosphere, not only must the hydrocarbon content be so balanced that there will be only the necessary small deposition of carbon due to catalytic decomposition at the surface of the steel, but there must be no undue decomposition on the muffle wall.

When using metal muffles it has been found that more than a very little Ni in a Fe-Cr alloy causes much decomposition and changes the composition of the gas. Ni-Cr thermocouples and protecting tubes deteriorate very rapidly in carburizing atmospheres and need frequent checking and renewal.

The effect of the walls on the atmosphere and of the atmosphere on the walls must also be considered. Refractories for controlled atmosphere furnace walls or muffles that will be attacked by a reducing atmosphere at the temperatures in question or into which hydrocarbons can percolate and then crack with deposition of carbon and resultant splitting of the refractory have to be avoided.

The utility of an electric furnace with Ni-Cr resistors is limited since the atmosphere tends to produce rapid deterioration of the resistor. Globar resistors should be applicable. It should be recalled that the atmospheres used for gas carburizing form explosive mixture with air, so that suitable precautions must be taken.

Carburizing Furnaces

BATCH carburizing furnaces, provided with a muffle type into which the carburizing gas is passed, resemble the batch furnaces for hardening carbon steels, and, if provided with a separate unit for conditioning the gas to any desired composition, can be used for that purpose. They are also applicable to nitriding. Unless Globar resistors are used, muffles are provided even with electric heating in order to save the resistors from attack.

By tumbling the charge so as to expose it more uniformly to the gas, carburizing may be hastened so that a rotary type furnace is quite common.

Continuous carburizing furnaces are less common, and, on account of the explosive nature of the carburizing gas, they have to be engineered with particular care. Such furnaces have to be arranged to allow the work to pass through different zones at controlled

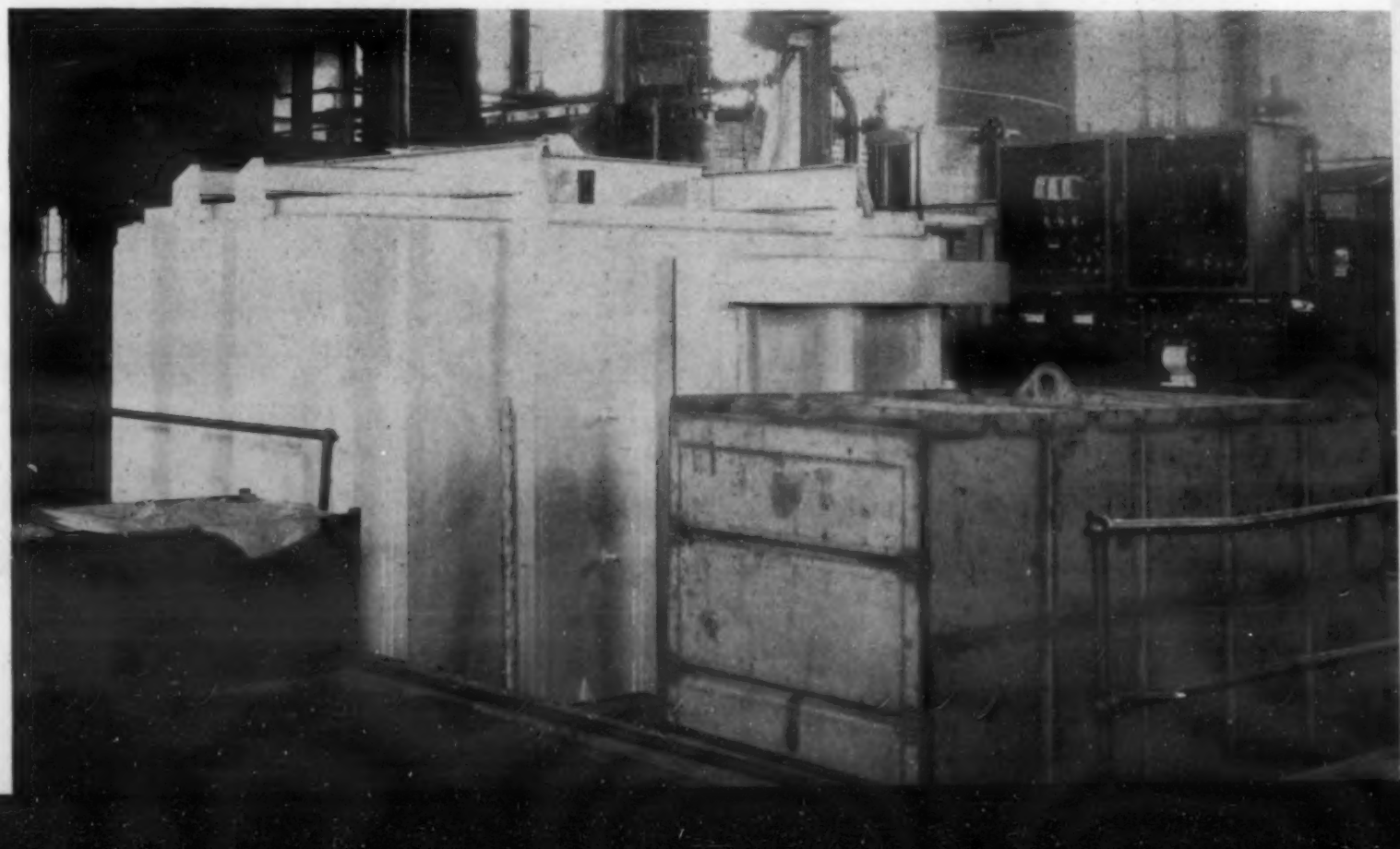


Fig. 43.—Westinghouse, Electrically Heated Furnace for Bright Annealing Sheets.

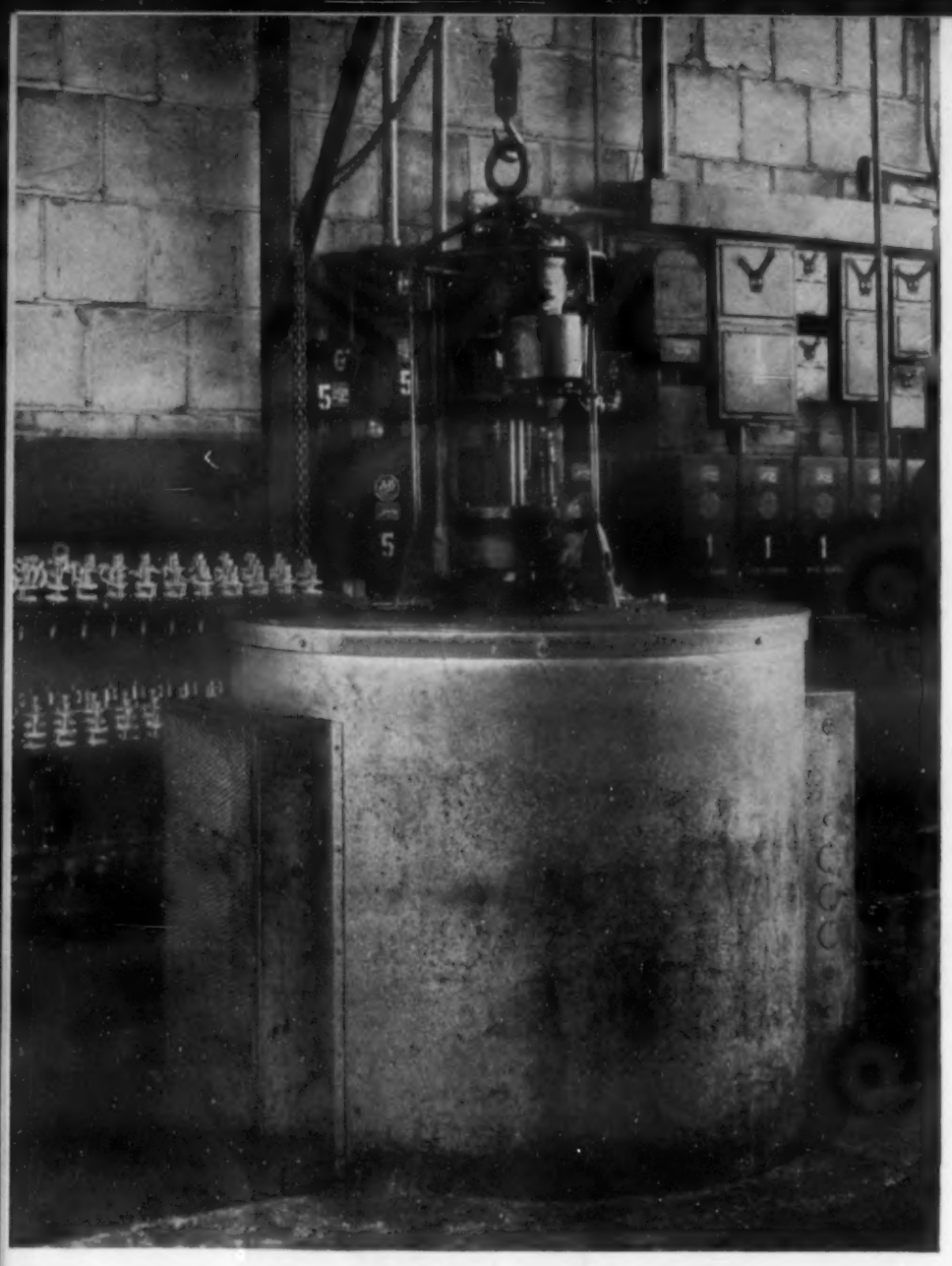


Fig. 44.—A Batch Carburizing Furnace Made by the Hevi Duty Electric Co., Using an Oil Drip. The oil drip falls into the discharge from a fan, thus circulating the hydrocarbon-hydrogen gas. The oil is not cracked prior to entrance into the carburizing chamber. Installation at the plant of the Johnson Motor Co.

times and temperature. Work requiring a very long diffusion period is usually handled in batch furnaces.

Summary

OF THE problems in heating solid steel, that at the highest temperature, of heating high-speed steel for quenching has been fairly well solved, for this usually requires but a relatively small heating chamber and thermal efficiency is not important compared to quality, so that controlled atmospheres can satisfactorily be applied. Either a weakly oxidizing atmosphere, resulting in a trace of scale but no decarburization, or a slightly carburizing atmosphere can be used.

Heating large pieces for forging or rolling has not yet been satisfactorily carried out with freedom from scaling and with good thermal efficiency. Direct fuel firing so that the flue gases are not oxidizing is out of the question as such temperatures, and heating through muffles or by electricity has yet to be satisfactory applied. Only carbon or Globar resistors will seve at such temperatures.

Heating medium carbon steels or carbon tool steels for quenching is accomplished in a variety of atmospheres either in muffles, or by electric resistors, or, if the temperature is not too high, by gas-fired radiant heaters. The atmospheres may be mildly carburizing, i.e., cracked oil vapor, or where a little scale can be borne, mildly oxidizing, but decarburizing conditions must be avoided. Dry H_2, with sufficient N_2 to make the H_2 content low, is a possibility. The gases most used are hydrocarbons burnt with a deficiency of air in a special generator, and usually, to avoid the necessity of especially delicate balance in composition, freed from all but traces of water vapor. This requires a good deal of apparatus and careful control.

A simple expedient is packing the work in cast iron borings and heating in the minimum amount of stagnant air, in a muffle or electric furnace. This simple expedient seems quite fool-proof and worthy of more recognition than has been given it. A somewhat similar expedient is the use of graphite, or of carbonaceous muffles about the work, preferably in an electric furnace.

Bright annealing is a different problem from the above because of the lower temperature. The proper atmosphere is a matter of dispute, much of the disagreement relating to the expediency of removing moisture or attempting to balance it. Deposition of soot may prevent the use of atmospheres otherwise applicable.

Atmospheres from the partial combustion of hydrocarbons or hydrogen atmospheres very high in nitrogen can be selected that will serve several bright annealing purposes. The practical maintenance of an atmosphere that will not decarburize, stain or etch the surface is not simple, even though it may be obtainable under laboratory control.

Practical Performance of Bright Annealing Outfits

One furnace maker remarks that the claims made for practical performance of bright annealing outfits are one of the sore spots of the metallurgical industry, for perfect bright annealing, from a practical production standpoint, has not yet arrived. Caution is therefore needed to make sure just what grade of surface will be demanded on the steel to be treated and that the atmosphere selected will really permit that surface to be consistently obtained. On account of the low temperature, the problem of materials of construction, for muffles, for resistors or radiant tube heaters, and for refractories, is not as difficult as in the higher temperature services.

Gas carburizing in hydrocarbon atmospheres, sometimes rather simple, sometimes quite complex, is successful, in spite of the difficulties in materials of construction. In all these problems, batch furnaces can be rather easily designed and many suitable ones are on the market.

Continuous furnaces offer much greater problems. There is often a necessity for different atmospheres in different temperature zones and the variations in size of parts to be heat-treated and in the times and temperatures required by different steels make it necessary that the design be specially engineered to fit the case. Some remarkable "heat-treatment machines" have resulted.

The fundamentals of the requirements as to composition of controlled atmospheres can be expressed in equilibrium curves, like those of Fig. 13, but, practically, many modifications are required by such variables as carbon and alloy content of the steel, rate of carbon diffusion in the steel, rate of gas flow, etc., so that experiment is usually required to select the cheapest suitable atmosphere for a given case.

Where the atmosphere can contain moisture, especially careful control is usually required. Much of the apparent discrepancy in the literature and in the results of practical experience may be ascribed to failure to take account of moisture, which is not shown by an Orsat gas analysis.

There is no one atmosphere available that will serve for all steels and all temperatures, desirable as this would be.

The production of a controlled atmosphere by regulated partial combustion of a hydrocarbon with a deficiency of air with or without the separation of water vapor, is a species of chemical manufacturing requiring suitable apparatus and, usually, skilled control. The tendency seems to be toward the removal of water vapor in a pre-treatment unit rather than to feed gas and air into the muffle.

The use of controlled atmospheres has been found very much worth while. H. A. Clark (personal communication, see also ref. 86) states that in the past three years 75 continuous heat-treating furnaces, using gas fuel have been constructed in Detroit, and at present 160,000,000 cu. ft. of gas are used for such purposes, or four times as much as in 1925. The controlled atmosphere problem is becoming of increasing significance in meeting the heat-treating requirements of the automotive industry, especially in the last two years.

Expansion in Use of Controlled Atmospheres

We can assume that continuous electrically heated furnaces are increasing in similar proportion. Such figures indicate the importance of precision heat-treating and since controlled atmospheres aid in precision results, we may expect that the use of controlled atmospheres is due for even greater expansion.

However, before rushing into the installation of a controlled atmosphere outfit, the small user should carefully consider the real requirement of the particular case and weigh the advantages of production of a non-scaled or non-decarburized surface with the cost of securing it. The most elaborate and complex outfit is not necessarily the best, and the mere use of a confined volume of air in an electric or muffle furnace, or the packing of the work in cast iron borings may serve satsifactorily in a good many cases. Where large production of heat-treated pieces with undamaged surfaces is required, it will probably pay to have a special continuous controlled atmosphere furnace designed to meet the particular conditions.

More information on the behavior of different steels in different atmospheres at different temperatures would facilitate the designer's task of selecting an atmosphere for a given use. It is almost hopeless to attempt to correlate the scanty and inconsistent data now available on this point, but there is a demand for definite information on it. More attention might well be given to the chemical problem of producing suitable atmospheres cheaply enough without requiring too complex equipment for their production.

There is an especial field for an atmosphere that will work on a wide variety of steels without requiring skillful juggling to maintain it at the proper composition.

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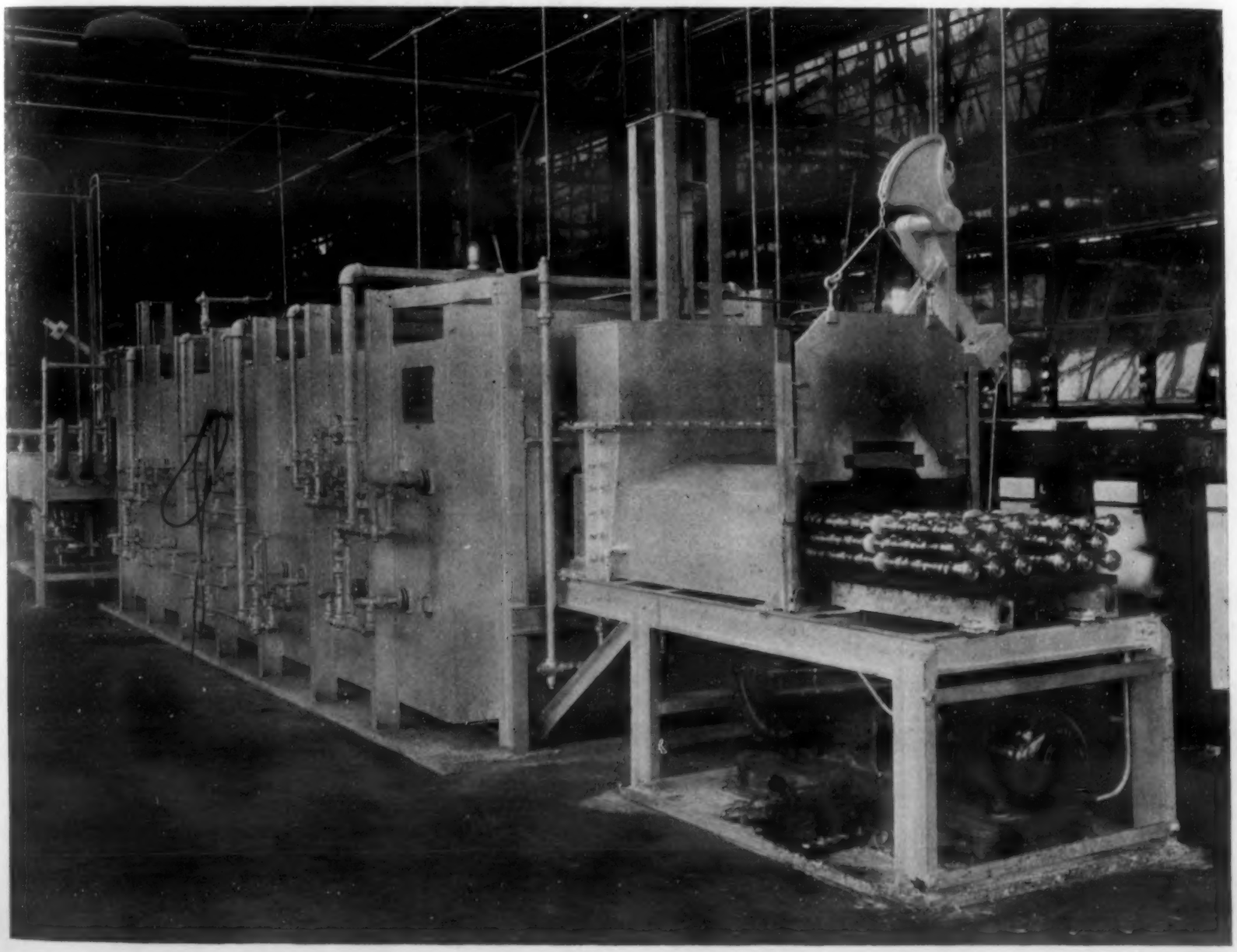
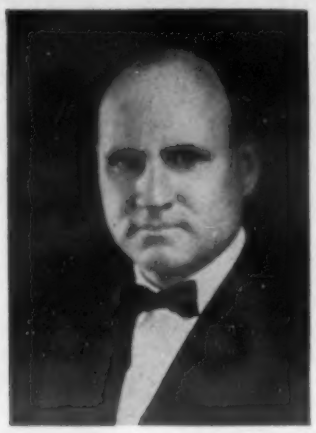
Fig. 45.—A Surface Combustion Continuous Gas Carburizing Furnace, This One at the Olds Motor Co.



October Medalists

F. J. Tone

C. A. McCune



Zay Jeffries

T. D. Yensen

N. A. Ziegler

SEVERAL MEDALS and awards were bestowed on distinguished members of three technical societies at conventions in October.

The Acheson Medal for distinguished achievements in electrothermics was presented to Dr. Frank J. Tone, president of the Carborundum Co., by The Electrochemical Society.

The Samuel Wylie Miller Medal was awarded to Charles A. McCune, secretary of the Magnaflux Co., New York, by the American Welding Society.

The Albert Sauveur Achievement Award was given to Dr. Zay Jeffries by the American Society for Metals. The society also awarded the Henry M. Howe Medal to T. D. Yensen of the Westinghouse Electric & Mfg. Co. and N. A. Ziegler, both of Pittsburgh, for the best paper published in the *Transactions* during the year.

Nucleization of Graphite by Manganese Sulphide

By H. A. SCHWARTZ

Manager of Research, Nat'l Malleable & Steel Castings Co., Cleveland

THE ACCOMPANYING MICROGRAPH Fig 1, (unetched 500 diameters) shows a type of nucleization of secondary graphitization recently observed by Chas. H. Junge in the writer's laboratory. As is well known (see "A Note on the Metallography of Ferrite in Malleable Cast Iron" by H. A. Schwartz and C. H. Junge, *Transactions* of the American Foundrymen's Association, Vol. XLII, page 94, 1934) secondary graphitization customarily begins at a cementite-solid solution interface, as shown in Fig. 2. Graphitization is quite possible in non-eutectiferous iron-carbon-silicon alloys in which such interfaces may not exist. In such alloys the graphite is rather commonly seen to grow about so called "manganese sulphide" inclusions, as in the illustration. We do not remember having seen this type of nucleization described in the literature.

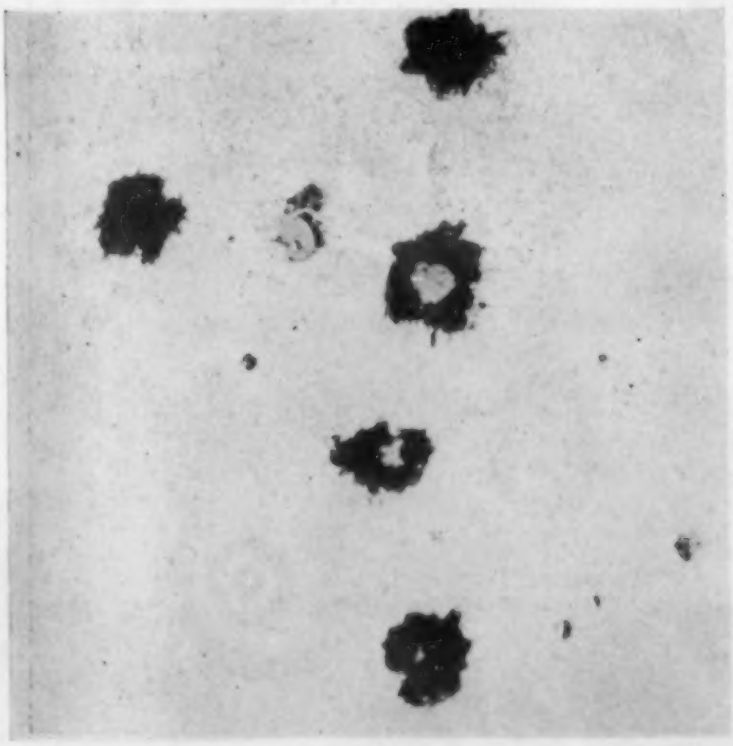


Fig. 1 (Left)

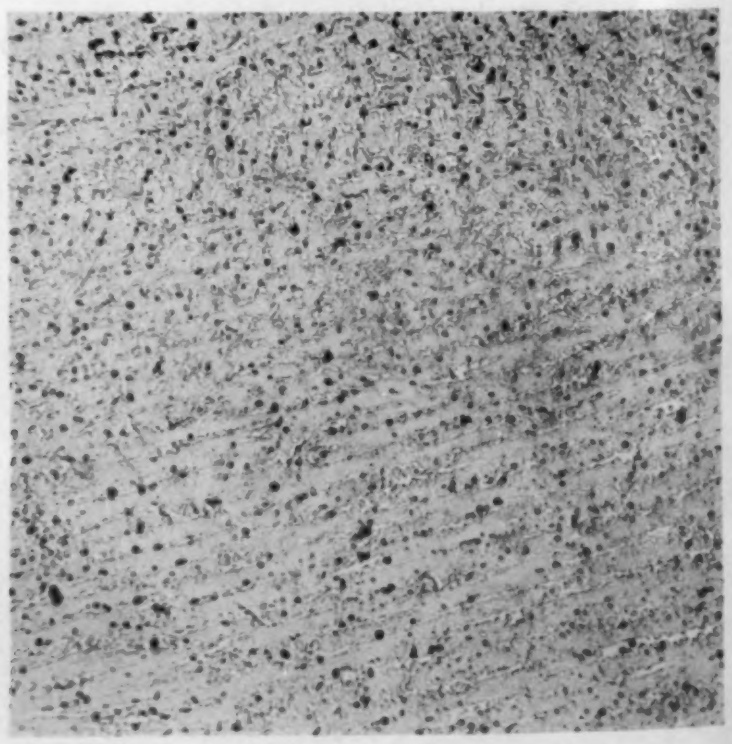


Fig. 2 (Right)

Trends in American Alloy Steel Output

By E. F. CONE

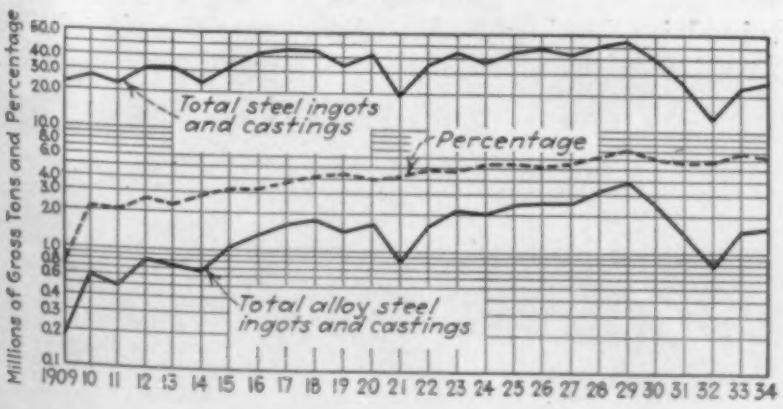
IN SPITE OF THE SEVERE depression through which the American steel industry has passed, with consequent large decreases in the output of steel ingots and castings, the alloy steel industry has by no means suffered similar losses. It may be conservatively stated that this branch of the steel industry has at least held its own, as judged by the statistics of the American Iron and Steel Institute. It is the aim of this brief analysis of these statistics to survey the progress of the alloy steel industry over a period of 26 years or since the data have been collected, with special emphasis on the effect of the depression. The last analysis of this nature was published in *Steel*, Aug. 27, 1934.

Percentage of Alloy Steel of Total Steel Output

Analyzing the record of the percentage of the output of alloy steel of the total steel production for the country, it will be seen from Table I and Fig. 1 that the 1934 production of alloy steels of 1,612,275 gross tons was 6.19 per cent of the total steel ingots and castings made. While this percentage is not as large as that for 1933 (6.66%) it is the second largest since 1929 when it was 7.01 per cent. In fact the 1934 percentage is the third largest on record—excelled only in 1929 and 1933.

A partial measure of progress during the depression period (1930 to 1934) as compared with the pre-depression years (1925 to 1929) is the average for both those 5-year periods. For the years 1925 to 1929 the average percentage of alloy steel output of total steel was 5.86 per cent—for the 1930 to 1934 period, this average percentage was 6.60 per cent. On this basis of comparison no ground was really lost—there was a slight gain. But the increase would probably have been much larger had there been no depression.

Fig. 1.—Relation of Alloy Steel Output to Total Steel Output for 26 Years.


Millions of Gross Tons and Percentage
Total steel ingots and castings
Percentage
Total alloy steel ingots and castings
1909 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

Tons of Total Steel to One Ton of Alloy Steel

A compilation of the tons of total steel made to one ton of alloy steel is found in column 4 of Table I. Twenty-six years ago there were 131.6 tons of total steel produced to one ton of alloy steel. By 1929 this had been reduced to only 14.2 tons. Since then there has been some loss, judged on this basis, the figure for 1934 having been 16.1 tons of total steel to one ton of alloy with the range during the five depression years having been from 15 tons to 17.8 tons.

Table I.—Production of Alloy Steel Ingots and Castings in United States—Gross Tons

	Total Alloy Steel	Total Steel	Per Cent Alloy Steel	Tons of Total Steel to 1 Ton of Alloy Steel
1909	181,980	23,955,021	0.75	131.6
1910	567,819	26,094,919	2.17	45.9
1911	481,459	23,676,106	2.03	49.1
1912	792,501	31,251,303	2.53	39.4
1913	714,357	31,300,874	2.28	43.8
1914	646,953	23,573,030	2.75	36.3
1915	1,021,147	32,151,036	3.17	31.4
1916	1,362,615	42,773,680	3.18	31.3
1917	1,644,335	45,060,607	3.65	27.4
1918	1,787,852	44,462,432	4.02	24.8
1919	1,481,188	34,671,232	4.27	23.4
1920	1,660,292	42,132,934	3.94	25.3
1921	809,548	19,783,797	4.10	24.3
1922	1,673,496	35,602,926	4.70	21.3
1923	2,106,489	44,943,696	4.70	21.3
1924	2,026,409	37,931,939	5.35	18.7
1925	2,432,973	45,393,524	5.36	18.6
1926	2,463,414	48,293,763	5.10	19.6
1927	2,531,748	44,935,185	5.59	17.7
1928	3,214,909	51,544,180	6.23	16.0
1929	3,957,207	56,433,473	7.01	14.2
1930	2,443,311	40,699,483	6.00	16.7
1931	1,455,913	25,945,501	5.61	17.8
1932	798,604	13,681,162	5.84	17.1
1933	1,547,183	23,232,347	6.66	15.0
1934	1,612,275	26,055,289	6.19	16.1

Alloy Steels in Electric Furnaces

A new record was made in 1934 in the percentage of alloy steels made in electric furnaces. An inspection of Table II and Fig. 2 will show that the 299,236 tons of alloy steel made in electric furnaces were 19.18 per cent of the total alloy steel produced. One factor in this showing is doubtless the increased demand for stainless and corrosion resisting steels. The 1934 percentage of 19.18 per cent is only slightly larger than that for 1933 and the expansion since the 12.87 per cent in 1929 has been definitely higher.

This upward trend may be explained as due to several causes. Small heats of alloy steels were

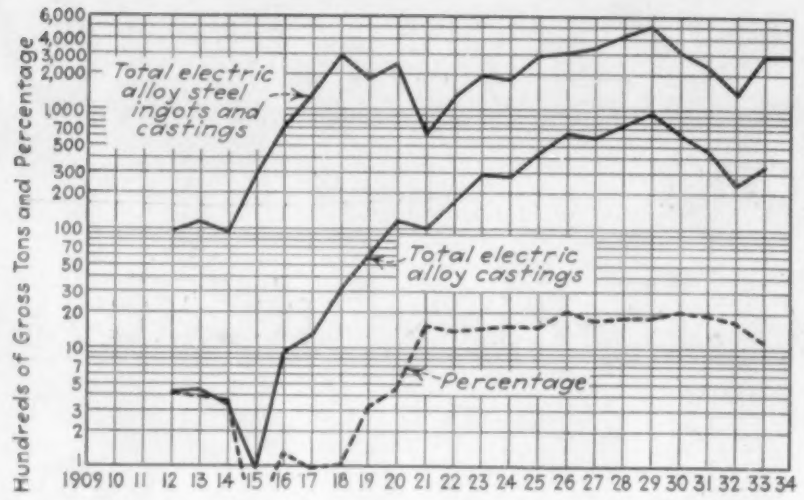


Fig. 2.—Relation of Electric Alloy Steel Castings to Total Alloy Steel Made in Electric Furnaces Since 1913. Data for 1934 not available.

available from electric furnaces and also the demand for alloy steels in general and the chromium and chromium-nickel steels in particular has been increasing. These are the main causes of the splendid showing—17.65 per cent—in the low year of the depression, 1932. The same facts apply to 1933 and 1934. Based on these trends the future of electric melting, in both arc and induction electric furnaces, is full of promise.

Trend Downward in Alloy Steel Castings

So much for the alloy steel industry as a whole which includes ingots and castings. If the developments in the alloy steel castings industry are studied separately, the picture is quite a different

Table II.—Production of Alloy Steels Made in Electric Furnaces in United States—Gross Tons

	Electric Alloy-Steel	Total Alloy Steel	Per-Cent of Electric Alloy Steel of Total Alloy
1909	...	181,980	...
1910	608	567,819	0.11
1911	...	481,459	...
1912	9,619	792,501	1.21
1913	11,264	714,357	1.57
1914	9,344	646,953	1.44
1915	27,944	1,021,147	2.73
1916	71,129	1,362,615	5.22
1917	130,578	1,644,335	7.94
1918	290,961	1,787,852	16.26
1919	181,632	1,481,188	12.26
1920	245,572	1,660,292	14.78
1921	63,246	809,548	7.81
1922	125,419	1,673,496	7.49
1923	194,976	2,106,489	9.25
1924	188,563	2,026,409	9.30
1925	293,780	2,432,973	12.00
1926	306,811	2,463,414	12.45
1927	343,517	2,531,748	13.57
1928	433,096	3,214,909	13.47
1929	510,030	3,957,207	12.87
1930	300,520	2,443,311	12.51
1931	232,113	1,455,913	15.94
1932	140,877	798,604	17.65
1933	296,210	1,547,183	19.11
1934	299,236	1,612,275	19.18

one—during the depression the trends have been decidedly downward.

An analysis of the alloy steel castings statistics, as given in Table III, for the 26-year period, shows that last year the percentage of alloy castings of the total alloy steel ingots and castings produced was only 1.37 per cent. This is the smallest on record. The 16,731 gross tons of such castings made in 1934 was less than the 23,002 tons made 26 years ago. The 1934 percentage of only 1.37 per cent compares with 4.63 per cent in 1933 and with 12.64 per cent in 1909. The large percentages from 1909 to 1914 are accounted for, in part at least, by the heavy production of cast alloy steel locomotive frames.

The proportion of alloy steel castings made in electric furnaces in 1934 is not available because the Institute's data do not report this item. In 1933 the quantity of alloy steel castings, electrically melted, was 11.49 per cent of the total alloy electric steel made. The peak was 20.86 per cent in 1926.

Table III.—Production of Alloy Steel Castings in United States—Gross Tons

	Total Alloy Castings	Total Alloy Steel	Percentage of Alloy Castings of Total
1909	23,002	181,980	12.64
1910	29,357	567,819	5.17
1911	56,290	481,459	11.69
1912	103,109	792,501	13.01
1913	88,927	714,357	12.44
1914	69,846	646,953	10.79
1915	97,896	1,021,147	9.58
1916	56,458	1,362,615	4.14
1917	67,529	1,644,335	4.10
1918	66,485	1,787,852	3.71
1919	45,372	1,481,188	3.06
1920	68,353	1,660,292	4.11
1921	40,255	809,548	4.97
1922	59,104	1,673,496	3.53
1923	92,220	2,106,489	4.37
1924	85,984	2,026,409	4.24
1925	112,583	2,432,973	4.63
1926	146,101	2,463,414	5.93
1927	145,844	2,531,748	5.72
1928	169,684	3,214,909	5.28
1929	192,920	3,957,207	4.87
1930	126,128	2,443,311	5.17
1931	89,903	1,455,913	6.17
1932	41,044	798,604	5.14
1933	71,783	1,547,183	4.63
1934	16,731	1,612,275	1.37

Inadequacy of Official Data

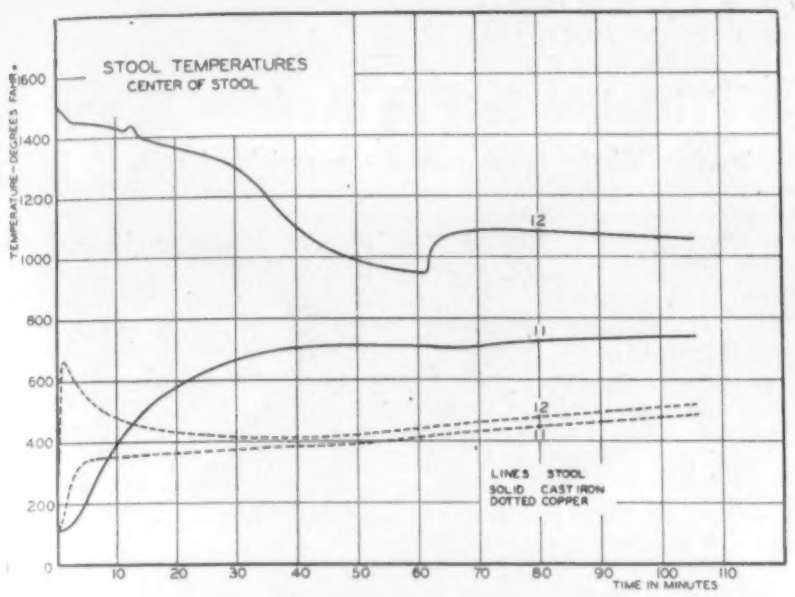
In an article of this nature it is necessary to call attention to the fact that the statistics of the American Iron and Steel Institute on alloy steels do not present the true picture because of the difference in interpretation of what is an alloy steel. So far as they go, the data form a basis for comparison, but they do not tell the whole story. A proper and comprehensive definition of an alloy steel is sadly needed by the steel industry—not only as a basis for statistical review, but for other obvious reasons. The fact also that some companies will not cooperate in giving statistics to the Institute is another regrettable and, it seems to us, unwarranted drawback.

It is dangerous to make predictions. But it is reasonable to postulate that, on the basis of the fact that the alloy steel industry as a whole has maintained its footing during the depression, it will go forward with added vigor as normal times return.

LETTERS TO THE EDITOR

Copper Stools for Ingot Molds

To the Editor: I shall appreciate it if you will publish a statement in an early issue of METALS & ALLOYS to the effect that the wrong diagram, but correct caption, was used



for Fig. 16 (page 216, August, 1935, issue) in the article—"Copper Stools for Ingot Molds." The illustration which should have been used is hereby submitted. (It is reproduced herewith.)

Clyde E. Williams,
Director

Battelle Memorial Institute
Columbus, Ohio.

Controlled Atmospheres in Steel Treating

To the Editor: We have read the August and September installments of the article on controlled atmospheres with considerable interest.

We notice that in the brief mention you make of the atmosphere produced by Sentry Diamond Blocks you have classed this as carburizing, by referring to Fig. 13. As Stansel's chart, Fig. 13, stops at 1650 deg. F., we can not see how it applies to hardening high-speed steel at 2350 deg. F.

Sentry Diamond Blocks produce a neutral atmosphere between decarburization and carburization. If we wanted a leaner atmosphere, it would be easy to produce as for instance by making a hole in the muffle to let in more oxygen, but we have found the correct atmosphere to be as described in the Winter patents.

You undoubtedly wonder why the Diamond Block atmosphere is richer than is generally used in other types of equipment without being carburizing. We believe the characteristics of a certain type of scale explain the reason for this apparent discrepancy. Rheinlander notes that, if the atmosphere is not sufficiently oxidizing, the scale will not come off freely. In other words we believe this type of close adhering scale practically amounts to a glaze which prevents decarburization.

In a number of places in your article you mention the rate of carbon diffusion as a factor in the rate of decarburization, but in no place is the penetration of the scale mentioned as a factor in the rate of decarburization. That this is a factor is indicated by Cobb's findings that, when scaling ceased, decarburization began and similar reports on various steels by different authorities.

In our experience a very thin glaze of scale will sometimes prevent decarburization on certain steels at certain temperatures, particularly on tungsten high-speed steels. If the richness of the atmosphere is slightly increased, decarburization results, and to get from this zone into carburization, a whole lot richer atmosphere is required. Some workers having secured work that was not decarburized, and on which the amount of close adhering scale was not very noticeable, have classified this as the correct atmosphere, but actually it is a long way off in analysis from the point between carburization and decarburization.

We feel when this and other matters explained in Murray Winter's patent are thoroughly understood, the principal source of present misunderstanding will not only be cleared up, but Murray Winter will receive a lot of credit for the pioneer work which is not as yet fully comprehended and appreciated.

The Winter patents will amplify the information contained in your article and clarify certain apparent discrepancies.

P. B. Crocker

The Sentry Co.,
Foxboro, Mass.

Nickel in Precious Metal Alloys

To the Editor: The controversial comment in the July issue of METALS & ALLOYS on the subject of nickel in precious metal alloys is interesting, inasmuch as nickel has been used extensively in dental alloys for many years without a great deal of criticism. This was probably due more to the efficacy of intensive advertising than to any metallurgical advantage to be gained by its use. The dental profession, reluctant to dispute the word of those presumably more informed on metallurgical matters than they, fostered its further use. However, as more reliable data are being published on the subject, it is becoming apparent that nickel is a dangerous addition to a dental alloy and is the cause of many casting failures and fabricating difficulties in wrought alloys.

A nickel-bearing casting gold may be used with some success if the ratio of platinum metals to nickel is sufficiently high, but this invariably raises the casting temperature, thus jeopardizing the soundness of the alloy by excessive oxidation of the other constituents. Nickel increases the strength of the alloy in the quenched condition but inhibits its capacity to harden at higher temperatures, although nickel itself imparts considerable hardness with low temperature hardening treatments. The equilibrium conditions of nickel with gold and silver, both important constituents of dental alloys, are such that it forms heterogeneous alloys which are, obviously, not conducive to successful dental castings.

When cooled slowly these alloys form an intergranular network, rich in nickel, definitely lacking in cohesion and susceptible to cracking if fabricated. This tendency toward boundary segregation may be so pronounced, after the metal has been given certain hardening treatments, that the metal will virtually spring apart if the metal, while stressed, is heated or is immersed in a pickling solution.

I agree with Mr. Souder that there is no one test which will determine, simultaneously, the ability of dental alloys to withstand the chemical action of oral fluids, certain medicaments and food. The corrosion resisting ability of an alloy, susceptible to hardening by heat treatment, is a function of the chemical reactivity and dispersion of the separating phase.

Tarnish, a special phase of the study of corrosion, is usually preceded by a superficial action. In the case of nickel-bearing golds, cooled slowly as they are by the standard dental methods, the nickel-rich phase concentrated at the grain boundaries is readily attacked. This action, augmented by the slight stress produced during mastication, forms an etched intercrystalline network which affords space for the accumulation of mucid deposits and corrosion products giving the appearance of a continuous discoloring film.

It is, therefore, not so simple a matter as the amount of gold plus platinum metals that determine a nickel-bearing dental alloy's resistance to tarnish, but involves, more specifically, the ratio of platinum metals to nickel, the amount of stress, the nature of the tarnish medium, the alloy's previous heat treatment and the health and diet of the individual upon whom the dental work has been done.

It is paradoxical that the element designed to be a substitute for the platinum metals can, really, only be used successfully when sufficient amounts of the platinum metals are present.

There is apparently nothing so noble as inherent nobility.

L. H. DeWald.

6324 S. Artesian Ave.,
Chicago.

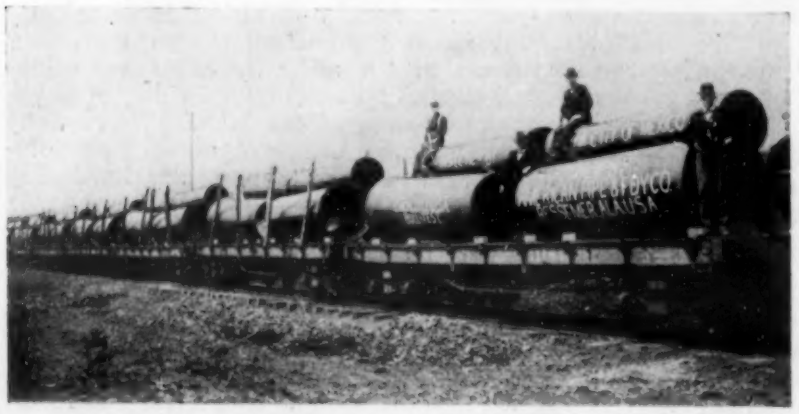
Inspecting Cast Iron Pipe in the Late Nineties

To the Editor: The article on "The Metal-Casting Industry" in your August, 1935, issue (pages 209 to 211) is an interesting description of the wide-spread application of metal castings. While some foundrymen may regard the picture as incomplete, I think Prof. Campbell rendered casting makers a service in effectively indicating, in a short article, the way in which the foundry's product is now being extensively utilized.

The contribution included two illustrations of long cast iron pipe lines, having diameters of 48 in. and 36 in. These pictures call to mind an inspection job that was assigned to me as an employee of Robert W. Hunt & Co. many years ago. During the late nineties a contract was made for the manufacture by what was then the American Pipe & Foundry Co. to produce at its foundry in Bessemer, Ala., a large amount of cast iron pipe and special fittings for the drainage system of the City of Mexico, which commissioned Captain Hunt's firm to inspect the material.

As I remember it, there were approximately 9 miles of 42-in. pipe, 7 miles of 30-in. pipe, and several miles of 6-in. and 8-in. pipe as well as fittings produced at the Alabama plant, and inspected by me in 1899. The language of the specifications was Spanish, and the dimensions were prescribed in the metric system. The requirements were identical with those covering the manufacture of high grade water pipe as then made in America, so far as quality of iron and dimensional accuracy were concerned. The material was of extraordinarily high grade for drainage purposes. Every length of pipe was hydrostatically tested, individually weighed, had its consecutive number cast on it, and had its consecutive number and correct weight painted on it. Daily I made transverse tests of the iron, which had to meet what were then regarded as rigid requirements.

The material was shipped from Bessemer, Ala., to the City



of Mexico by rail in full train loads, each generally made up of 25 flat cars. The manner in which the 42-in. and 30-in. pipe were loaded for the long ride is shown by the accompanying illustration, in which the "guy" holding callipers and inspection hammer and wearing a black shirt that antedated Mussolini's, was the undersigned.

This job had more than technical interest because the drainage project for the City of Mexico is said to have been started by Montezuma, who planned for tunnelling through the mountains surrounding the City of Mexico to provide the required outlet. It is stated that Cortez subsequently put engineers at the task of carrying through the project initiated by Montezuma, but is remained for Diaz during the hectic nineties to arrange for completing the drainage system (according to plans that were materially modernized), in which a large tonnage of gray iron castings was used.

I have often wondered whether there is a drainage system in any country which has material of higher quality than was supplied nearly 40 years ago by an American foundry to the City of Mexico.

R. A. Bull.

Consultant on Steel Castings,
541 Diversey Parkway, Chicago

Titanium-Bearing Sands of Japan

To the Editor: I have read the articles by P. M. Tyler entitled "Titanium" in your issues of April and May of this year with deep interest.

Scientific researches about titanium in Japan have been carried out by many investigators and many papers have been read since 1918. Because of Japan's poor resources in iron ores, her only available source of iron remaining, since the importation of ores is obstructed, may be titaniferous iron sands. So the government encouraged and subsidized their utilization. Now three main courses of utlizations may be laid down: To reduce them to a briquetted form as sponge iron; to smelt in an electric furnace to produce pig iron or steel directly; and to recover ore iron in solution and the titanium in the residue by the wet or combined wet-dry methods.

The feasibility of smelting them in the modern blast furnace is still undetermined. A company was recently established for the production of electric vanadium steel directly from the titaniferous iron sands containing up to 0.6 per cent of V_2O_5, and a few companies are in the preliminary stages of the manufacture of TiO_2 from the ilmenite sands (60-65% TiO_2). Two plants are now producing ferrocarbontitanium (15 to 20% Ti, 6 to 9% C) by the reduction of ilmenite in arc furnaces.

Japanese iron sands are mostly derived from basic igneous rocks and are spread over almost all the coast of Japan proper, Kyu-Shu and Hokkaido. The most concentrated localities are on the east coast in Aomori and Iwate prefectures, where stratified thick layers of magnetic sands are cemented up with ferric mud. The official estimated quantities amount to 10,000,000,000 tons with contents of 20 to 30 per cent of Fe and 8 to 12 per cent of TiO_2 as mined.

Japanese contributions are standing foremost, I suppose, in the study of the titaniferous iron ores, for every Japanese knew that the famous Japanese swords, in which their ancestors have had such jealous interest, had been manufactured from the smelting of these iron sands with honorable and religious will. There is a considerable amount of Japanese literature on the subject which deserves attention.

R. Maeda

Metallurgical Dept.,
Faculty of Engineering,
Tokyo Imperial University,
Tokyo, Japan.

A Correction—Wrought Aluminum Alloys At Elevated Temperature

IN the October issue of METALS & ALLOYS there was published an article, pages 284 to 288, on "Properties of Wrought Aluminum Alloys at Elevated Temperatures" by F. M. Howell and D. A. Paul of the Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa. Through some regrettable error, the captions for the 17 illustrations were wrong. They should individually have been as follows:

Fig. 1.—Tensile Strength and Yield Strength of 17S-T at Different Temperatures.
Fig. 2.—Elongation of 17S-T at Different Temperatures.
Fig. 3.—Reduction of Area of 17S-T at Different Temperatures.
Fig. 4.—Brinell Hardness of 17S-T after Heating at Different Temperatures.
Fig. 5.—Tensile Properties of 14S-O at Room and Elevated Temperatures.
Fig. 6.—Tensile Properties of 14S-T at Room and Elevated Temperatures.
Fig. 7.—Tensile Properties of 17S-T at Room and Elevated Temperatures.
Fig. 8.—Tensile Properties of 18S-O at Room and Elevated Temperatures.
Fig. 9.—Tensile Properties of 18S-W at Room and Elevated Temperatures.
Fig. 10.—Tensile Properties of Y-alloy at Room and Elevated Temperatures.
Fig. 11.—Tensile Properties of 24S-T at Room and Elevated Temperatures.
Fig. 12.—Tensile Properties of 32S-T at Room and Elevated Temperatures.
Fig. 13.—Tensile Properties of 51S-W at Room and Elevated Temperatures.
Fig. 14.—Tensile Properties of 51S-T at Room and Elevated Temperatures.
Fig. 15.—Tensile Properties of A51S-T at Room and Elevated Temperatures.
Fig. 16.—Tensile Properties of 53S-O at Room and Elevated Temperatures.
Fig. 17.—Tensile Properties of 53S-T at Room and Elevated Temperatures.

In the reprints which have been made these and other minor errors have been corrected.

1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

The Concentrator and Cyanide Plant of the Hudson Bay Mining and Smelting Company, Limited. S. P. Lowe. *Transactions of the Canadian Institute of Mining & Metallurgy*, 1935 (in *Canadian Mining & Metallurgical Bulletin* No. 277, May) pages 163-175. A series of flow sheets for each section of the plant with many detailed data on size of equipment, life, power requirements, repair costs, operating personnel, etc. are given. In Cu flotation, maximum extraction of Au, Ag and Cu is the aim, rather than production of high-grade concentrates. Minerec B and Aerofloat 25 gave best extraction. In Zn flotation, a concentrate containing 46% Zn is the aim, even if extraction must be sacrificed to maintain grade. The ore contains a variable amount of marmatite (high Fe sphalerite); at times the pyrite floats as readily as the marmatite which makes production of a high-grade concentrate difficult. The cyanide plant is unique in 3 respects: (1) agitation is at a pulp dilution of 65% solid and lasts only from 2½ to 4½ hours; (2) there is an extremely small amount of O_2 concentration in the solution; and (3) all solution that has been in contact with the ore is discarded. AHE (1)

Gold-bearing Black-sand Deposits of Graham Island, Queen Charlotte Islands. Joseph T. Mandy. *Transactions of the Canadian Institute of Mining & Metallurgy*, Vol. 37, 1934, pages 563-572. Concentration followed by amalgamation has been the most popular means of Au recovery. Possible application of flotation is considered. AHE (1)

Increase in Production of Molybdenum. P. Macre-Patton. *Mining Journal*, Arizona, Vol. 18, May 15, 1935, pages 3-4. An active search is reported for new sources of molybdenite and wulfenite from which the production of Mo in 1934 was the largest on record, being 65% greater than in 1933. About 80% of the 1933 U. S. A. production was exported. The use of the toughening effect of Mo, in small amounts in steel and its use in other ferrous alloys are the principal applications. Discussion of mining and concentrating methods for the Mo ore is included. WB (1)

Lead and Zinc Mining and Milling in the United States; Current Practices and Costs. Chas. F. Jackson, John B. Knaebel & C. A. Wright. *United States Bureau of Mines, Bulletin* No. 381, 1935, 204 pages. Concentrating methods for 16 mills in 10 States are summarized, flow sheets are given, and finally generalizations are drawn for hand sorting, crushing, grinding, sizing and classifying, jigging, tabling, flotation, dewatering, grade of products and recoveries, disposal of tailings, costs, etc. Six plants use gravity concentration supplemented by flotation; at 3 of these jigs and tables are used, at 2, jigs only, and at 1, tables only. Flotation reagents are discussed. AHE (1)

1c. Flotation

The Physical Chemistry of Flotation. V. Flotation of Graphite and Sulphur by Collectors of the Xanthate Type and Its Bearing on the Theory of Adsorption. Ian William Wark & Alwin Birchmore Cox. *Journal of Physical Chemistry*, Vol. 39, Apr. 1935, pages 551-559. The response of graphite and S to collectors of the xanthate type is of considerable theoretical significance. It does not seem possible to connect the response of a mineral with the possession of any particular type of lattice structure by the mineral. S and cleiophane, cerussite and anglesite, graphite, galena and chalcopyrite, Cu and Au represent among them several different types of crystal lattice, but they all absorb xanthates from solution and, what is more significant, all lead to the same maximum angle of contact for each xanthate at a line of triple contact air-solid-xanthate solution. (See also *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 114 L-3, L-4, L-5). The external or effective surface is the same in all cases, and consists entirely of the non-polar groups of the oriented adsorbed xanthate molecules. The observations furnish sufficient evidence to prove that certain of the proposed theories of adsorption cannot be of general application. EF (1c)

Milling and Metallurgy at Wright-Hargreaves Mines, Limited. H. Vincent Wallace, Malcolm Black, Hector Farah, et al. *Transactions Canadian Institute of Mining & Metallurgy*, 1935 (in *Canadian Mining & Metallurgical Bulletin No.* 274, Feb.) pages 31-54. A typical ore analysis is Au $13-14/ton (at $20.67/oz.), Ag trace, Cu 0.013, FeS_2 1.780, Al_2O_3 1.200, $CaCO_3$ 2.530, MgO 1.479, Te+Pb+Mn+Mo 0.480 and insoluble 92.520%. The flow sheet, providing for cyanidation followed by flotation and retreatment of the concentrates, is discussed in detail. Flotation heads average $1.75, concentrates $62.00. Reagents used (average for the year) are Z-8 (butyl xanthate) 0.06, $CuSO_4$ 0.25, soda ash 0.09, cresylic acid 0.02, Dupont alcohols B23 and B 25 0.057 lb./ton of ore; reagent costs are 3.26 cents and total flotation costs are 12.0 cents/ton. Total average costs are $1.334. The average grade of precipitate is Au 46.11, Ag 9.33, Cu 15.9, Zn 9.31, and Te 6.29%. AHE (1c)

Beneficiation of Katanga Copper Ores (Aufbereitung der Kupfererze von Katanga). *Die Metallbörse*, Vol. 24, Dec. 8, 1934, page 1563; Dec. 15, 1934, pages 1594-1595. A detailed review of the present state of dressing of ores from the three principal deposits at Katanga, mainly on the basis of American publications. (*Engineering & Mining Journal*, 1933, page 280, 1934, page 401). EF (1c)

New Method for Treatment of Gold Bearing Ores at Baita (Roumania) (Nouveau mode de traitement des minerais aurifères à Baita (Roumanie)). Ch. Berthelot. *Génie Civil*, Vol. 106, June 15, 1935, pages 589-590. Concentrates produced before contained on the average 143 g. of Au and 598 g. of Ag per ton. They are reground and floated in a suspension alkalized with CaO in the presence of Aerofloat. The final concentrates contain 60-70% of Pb + Cu and 400-600 g./t. of Au and 2500-3500 g./t. of Ag. JDG (1c)

1d. Magnetic Separation

Apparatus for Determining Magnetic Constants of Mineral Powders. V. H. Gottschalk & C. W. Davis. *Progress Reports—Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 51-65. A modified isthmus permeameter having a spark-suppressed primary and a multiplier in the secondary circuit to regulate the effect of capsules functioning as a twin isthmus is used to obtain quantitative data and normal induction and hysteresis curves from small amounts of powdered material at fields surpassing 3000 oersteds. AHE (1d)

Magnetic Iron Ore from Texada Island, B. C. W. B. Timm *et al. Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 25-31. A very high-grade concentrate suitable for production of sponge Fe and coarse enough to sinter at a low cost was produced. AHE (1d)

Magnetic Measurements as an Auxiliary Means in the Evaluation of Iron Ores with Respect to Ore Dressing (Magnetische Messungen als Hilfsmittel bei aufbereitungstechnischen Untersuchungen an Eisenerzen). Ludwig Kraeber. *Die Naturwissenschaften*, Vol. 23, Mar. 8, 1935, pages 160-164. The Kaiser Wilhelm Institut für Eisenforschung opened a new department with the object of studying the utilization of low-grade Fe ores, the possibilities of magnetic roasting and subsequent magnetic separation. Contrary to metal powders, measurements on ferromagnetic powder materials are unsuitable. The development of a ferromagnetic balance and its characteristics are described. Measurements on para-magnetic and strongly ferromagnetic Fe-oxygen compounds are presented. Based on further determinations on siderite, light is thrown upon the magnetic roasting process. EF (1d)

1e. Amalgamation, Cyanidation & Leaching

Gold-Silver-Lead-Zinc Ore from the Yankee Girl Mine, at Ymir, British Columbia. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 143-150. A series of small-scale cyanidation tests were made on an ore assaying Au 0.625 oz. and Ag 3.00 oz./ton, Pb 3.14%, Zn 5.30%, and As 0.28%. The maximum Au extraction by direct cyanidation was 87%. By first grinding the ore with lime, washing and cyaniding, extraction was 95%. Solutions fouled rapidly; 40% had to be discarded with each pass. A flow sheet is suggested. AHE (1e)

Little Long Lac Gold Mines. Alan A. Barton. *Transactions Canadian Institute of Mining & Metallurgy, 1935 (in Canadian Mining & Metallurgical Bulletin* No. 274, Feb.) pages 21-30. Quartz veins are well mineralized with arsenopyrite, pyrite, and some chalcopyrite and stibnite and carry considerable visible Au. The ore is crushed and ground, passes over blanket tables, and is cyanided. The Au solution after clarification is precipitated by the Merrill-Crowe process. The precipitates are acid treated and melted into bullion. Heads average 0.70 oz. and recovery is 90-93.1%, 50% on the blankets. AHE (1e)

The Purification of Zinc Sulphate Solutions Intended for the Electrolytic Recovery of Zinc. S. W. Ross. *Proceedings Australasian Institute of Mining & Metallurgy* No. 95, Sept. 30, 1934, pages 167-199. In the Broken Hill and Roseberry ores, As, Sb, and Cu are impurities reducing current efficiency; Cd reduces the grade of the Zn; Cl deteriorates cell equipment. There are 4 stages in the treatment at Risdon: (1) with limestone to remove Fe, Al, As, Sb and SiO_2, (2) with Zn dust to remove Cu, Cd, Ag and traces of As, Sb, and Co, (3) Co removal, and (4) Cl removal. The solution going to (1) analyzes H_2SO_4 1.5, Al 0.015, Fe^{++} 0.015, Fe^{+++} 0.20, SiO_2 1.0, As 0.012, and Sb 0.0003 g./l. A basic sulphate of Fe is precipitated by the $CaCO_3$, carrying the As and Sb with it. Al is precipitated by a similar reaction. SiO_2, present as a colloid, is coagulated by the change from acid to basic condition and by CO_2. After treatment the solution contains SiO_2 100, Fe 1.0, As 0.1, Sb 0.1, Cu 105, Cd 210 mg./l. and Ag trace. In (2) Cu is precipitated readily by little more than its chemical equivalent of Zn; Cd requires much excess; for the 2 together a 50% excess is considered safe. Most of the Cu is precipitated before any substantial amount of Cd is dropped. According to the electrochemical series, Co should be precipitated by the Zn, but $Co_2(SO_4)_3$ is ionized to a minute extent only in strong $ZnSO_4$ solutions (precipitation of Co by Zn from a water solution of $Co_2(SO_4)_3$ is rapid). After this step the solution contains Cu 0.1, As 0.1, Sb 0.1, Cd 1.0, Ag trace and Co 20-25 mg./l. Co may be removed as Co_2O_3 by employing a powerful oxidizing agent; since Mn is preferentially oxidized and may amount to 1.0 g./l. the expense is considerable. In the presence of Cu and As, Zn will remove Co at 50-70°; its drawback is the health hazard as arsine is formed. The most satisfactory method of purification is $Co_2(SO_4)_3 + 6\ C_{10}H_6.NO.OH = 2\ Co(C_{10}H_6(NO)O)_3 + 3\ H_2SO_4$. Chloride Cl is undesirable in amounts over 75 mg./l., in other forms it is innocuous. About 5% of the circuit is treated with Ag_2SO_4 and Cl^- is reduced to less than 5 mg./l. AHE (1e)

Gold Ore from West Caledonia, N. S. W. B. Timm *et al. Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 75-78. Amalgamation recovered 75% of the Au from a minus 30 mesh ore containing 0.486 oz. Au/ton. Tabling of the tailing recovers 7.45% more; 70% of the Au in the concentrate can be recovered by barrel amalgamation to give an 80% overall Au recovery. Cyanidation of minus 48 mesh ore recovers 95% of the Au. AHE (1e)

Gold Ore from the Summit Lake District, Ontario. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 45-47. The ore assayed Au 0.66 oz./ton and As 0.43%. The Au occurred primarily in the arseno-pyrite. At 60% —200 mesh there was 96% extraction of the Au in 30 hours with reagent consumption of 0.32 lb. KCN/ton and 4.0 lb. CaO/ton. AHE (1e)

1

Gold Ore from Onaman Lake Area, Thunder Bay District, Ont. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 40-41. Cyanidation of an ore containing 0.20 oz. Au/ton gave 95% recovery in 24 or 48 hrs. Recovery by amalgamation was 50%, by flotation 86%. AHE (1e)

Gold Ore from Northern Metals, Limited, Larder Lake, Katrine Township, Ont. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 34-36. Best extraction (about 97%) was secured by cyanidation of ore ground 80% —200 mesh. AHE (1e)

2

Gold Ore from Norgold Mines, Limited, Bosquet Township, Abitibi County, Quebec. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 42-44. The ore, assaying Au 0.29 and Ag 0.05 oz./ton, responded readily to cyanidation—96.6% recovery in 24 hrs. at 66% —200 mesh. AHE (1e)

Gold Ore from Maskwa Gold Mines, Central Manitoba Area. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 48-53. Satisfactory recoveries of the 2.73 oz. Au and 4.66 oz. Ag/ton in the ore was obtained if ground 100% —200 mesh. Most of the Au occurs in pyrite; the presence of petzite, a Au-Ag telluride, will tend to retard the action of the cyanide upon the Au tied up in this mineral. The ore is not amenable to amalgamation. AHE (1e)

3

Gold Ore from Lakeland Gold Mines, Limited, Bourkes, Ont. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 37-39. Approximately 52% of the Au is free and can be amalgamated. Flotation recovers 86% of the Au, leaving 0.04 oz. Au/ton in the tailing. Cyanidation of —200 mesh ore gives 94.7% recovery and leaves a tailing containing 0.015 oz. Au/ton. Fine grinding is necessary to give high recovery. AHE (1e)

4

Gold Ore from the Home Gold Mining Company, Limited, Yale Mining Division, British Columbia. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 100-106. The ore assays Au 1.85 oz./ton, As 9.87, Fe 20.71, S 15.04, and Cu 0.14%. The Au occurs within the arsenopyrite as extremely fine particles of native Au, so fine that no commercial crushing would expose them to the action of the cyanide. Amalgamation recovers a maximum of 25%. Cyanidation of —200 mesh ore yielded only 64.1% of the Au. Roasting and cyanidation recovered 90%. AHE (1e)

5

Gold Ore from the Guelph Mine, Wawa, Michipicoten, Ont. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1935, pages 32-33. Cyanidation of —48 mesh ore gave 98% recovery in 48 hours; amalgamation and cyanidation of the tailing for 24 hours gave the same result. AHE (1e)

Gold Ore from Elbow Lake, Cranberry Portage, Manitoba. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 89-90. Cyanidation of —100 mesh ore gave a recovery of 94-97% of the Au and a tailing containing 0.01-0.005 oz. Au/ton. CaO consumption is about 7 lbs. and KCN 1 lb./ton. AHE (1e)

6

The Oxygen Content of Cyanide Solutions. F. J. Tromp & W. E. Schilz. *Journal Chemical, Metallurgical & Mining Society of South Africa,* Vol. 35, Apr. 1935, pages 301-315. Polemic with Prentice (see "A New Process for Oxygenating Solutions," *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 429). Various methods for determination of O_2 in cyanide solutions were studied and the limitations of each outlined. AHE (1e)

7

Amalgamation and Cyanidation. Edmund S. Leaver. *Progress Report—Metallurgical Division. 11. Studies on the Recovery of Gold and Silver. United States Bureau of Mines, Report of Investigations* No. 3275, June 1935, pages 7-14. Present methods for recovery of Au by amalgamation and cyanidation are reviewed. Au alloys readily with Hg provided both present clean surfaces. The presence of oils and grease, Sb and As minerals or soluble sulphides have a harmful effect. Very small, flaky particles of Au frequently are lost in amalgamation because of non-contact with the Hg. Au is readily soluble in cyanide solution. This method of treatment is particularly effective in the recovery of Au from tailings resulting from other types of concentration. Certain substances in ore are harmful in cyanidation—chiefly those that combine with cyanides and C which precipitates Au from solution. Zn dust is used to precipitate precious metals from cyanide solutions. AHE (1e)

8

Amalgamation During Fine Grinding of Gold Ores. E. S. Leaver & M. B. Royer. *Progress Report—Metallurgical Division. 11. Studies on the Recovery of Gold and Silver. United States Bureau of Mines, Report of Investigations* No. 3275, June 1935, pages 15-21. Crushing Au ores to 65 mesh in the presence of Hg increases Au recovery over that obtained by ordinary plate amalgamation. Too fine grinding with Hg causes excessive flouring and lower recovery of Au. A rotating-cylinder amalgamator gave as good Au recoveries and less Hg loss than crushing in the presence of Hg. Crystalline C, sulphides of As, Sb, Pb, Zn or Cu, or combinations of these with Fe sulphides, causes much Hg loss when crushing to 65 mesh in the presence of Hg. Much Hg is lost when added to mechanisms grinding pyritic ores containing pyrrhotite. Experiments on combined cyanidation, precipitation and amalgamation were not successful due to the failure of the Au to amalgamate. AHE (1e)

9

Gold Ore from Chartered Explorers, Limited, Sturgeon Lake, Ont. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 94-99. Amalgamation and blanket tests of an ore assaying Au 0.438 oz./ton and Cu 0.065% show that 85-90% of the Au is freed as native Au by grinding to 40% —200 mesh. Over 95% of the Au can be extracted by cyanidation at —48 mesh with approximately 55% —200 mesh. AHE (1e)

10

Gold Ore from the Canadian Pandora Gold Mines, Limited, Cadillac Township, Quebec. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 4-9. An ore containing 0.02-0.62 oz. Au/ton and 0.08-1.17% As was cyanided easily to give good extraction. AHE (1e)

Gold Ore from Buffalo Ankerite Gold Mines, Limited, South Porcupine, Ontario. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 10-12. Poor recovery was obtained at the mine in cyaniding an ore containing Au 0.215 oz. and Ag 0.05 oz./ton. Lower grade tailings can be made (1) by cyaniding —200 mesh ore or (2) grinding approximately 70% through 200 mesh, tabling out the pyrite, regrinding the concentrate all through 200 mesh, and cyaniding. AHE (1e)

Gold Ore from Bidgood Kirkland Gold Mines, Limited, Kirkland Lake, Ontario. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 107-111. The most practical method for treating this ore, assaying Au 0.22 oz. and Ag 0.08 oz./ton, was cyanidation with table concentration, regrinding, and reagitation of the pyrite. About 11% of the cyanide tailing was recovered as a pyrite concentrate containing 61% of the Au. The saving in grinding is great. The tailing assayed 0.01 oz. Au/ton. Flotation is not recommended because the tailing loss is too high, and would have to be done in a soda ash circuit necessitating filtering, washing and reconditioning with CaO before cyanidation would be possible. AHE (1e)

Gold Ore from the Beardmore Mine of Northern Empire Mines, Ltd., Jellicoe, Ont. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 60-67. Straight cyanidation seems to be the simplest and most efficient method of treating this ore, assaying Au 0.505 and Ag 0.12 oz./ton, Fe 5.10, S 0.80, As 0.18 and insoluble 73.65%. By grinding 100% —48 mesh and 77% —200 mesh and cyaniding 24 hours, 98% of the Au was extracted. Barrel amalgamation gave good results; plates recovered nothing. An hydraulic trap on the rod mill discharge recovered 62% of the Au. Corduroy blankets recovered 65.6%. AHE (1e)

The Solubility of Cuprous Chloride in Concentrated Hydrochloric Acid. Kiang-Shu Chang & Ya-Teh Cha. *Journal Chinese Chemical Society,* Dec. 1934, pages 298-306. The solubilities of cuprous chloride in a series of HCl solutions up to 12 mol. were determined at 25° C. by 2 independent methods. EF (1e)

The Addition of Lead Salts in Cyaniding Gold Ore. F. G. Macdonald & H. R. Adams. *Journal Chemical, Metallurgical & Mining Society of South Africa,* Vol. 35, Apr. 1935, pages 315-318. Soluble Pb salts (acetate or nitrate) are added to cyanide solutions (1) to precipitate harmful impurities such as soluble sulphides and (2) to form a Zn-Pb couple of greater activity as a precipitant than Zn alone. In the treatment of banket ore (1) is nonexistent. Evidence is presented to show that most Pb added before clarification is removed by the clarifiers. AHE (1e)

Investigations of Southern Gold Ores. B. W. Gandrud & R. E. Evans. *Progress Report—Metallurgical Division. 11. Studies on the Recovery of Gold and Silver. United States Bureau of Mines, Report of Investigations* No. 3275, June 1935, pages 47-50. Cyanidation of table concentrates of slaty ore from the vicinity of Albemarle, N. C., gave about 90% recovery of Au. Cyanidation recovered 97.6% of the Au in ore from the Parks mine in Georgia. Gold ore from the Edgefield district of S. C. was refractory to amalgamation and tabling, but cyanidation of —100 mesh ore gave 94.3% recovery with low cyanide consumption. AHE (1e)

Stamp-Milling and Amalgamation Practice at Goldenville, N. S. E. H. Henderson. *Transactions of the Canadian Institute of Mining & Metallurgy, 1935* (*in Canadian Mining & Metallurgical Bulletin* No. 278, June) pages 222-242. More than 85% of the Au is coarse, free, and recovered by amalgamation. A low-grade concentrate is obtained by tabling. Costs are $0.80/ton. Details are given. AHE (1e)

Milling Methods and Costs at the Concentrator of the St. Joseph Lead Co., Atlanta, Idaho. E. D. Gardner. *United States Bureau of Mines, Information Circular* No. 6836, Apr. 1935, 10 pages. The ore consists of quartz containing disseminated arsenopyrite and pyrite. Au occurs free and with the sulphides. The average assay for April, 1934, was Au 0.467 oz. and Ag 1.541 oz./ton. After amalgamation, the pulp is sent to a Dorr classifier. The overflow is floated using cresylic acid 0.084, pine oil 0.017, Barrett No. 4 creosote 0.13, K xanthate 0.064, and Aerofloat No. 25 0.067 lb. In April, 1934, Au recoveries were 89.55%, Ag 94.58%. Amalgamation recovered 70% and flotation 30%. Tailings assay Au 0.04 oz. and Ag 0.085 oz./ton. The concentrates assay Au 5.703, Ag 61.63 oz./ton, insol. 15.0%, Pb 0.3, CuO.3, As 6.0, and Fe 38.0%. Total costs were $1.162/ton. AHE (1e)

Gold Ore from Sullivan Gold Mines, Limited, Dubuisson Township, Abitibi County, Quebec. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 149-152. Cyanidation of —48 mesh ore containing Au 0.785 oz./ton gives 98.7% extraction in 24 hours and leaves a tailing containing 0.01 oz. Au/ton. Agitation for 48 hours reprecipitated some of the Au. AHE (1e)

Flotation Concentrate from Vidette Gold Mines, Limited, at Vidette Lake, B. C. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* 744, 1934, pages 145-148. It was not possible to produce a cyanide tailing lower than 0.69 oz. Au/ton from a concentrate assaying Au 11.875 oz. and Ag 26.27 oz./ton, Cu 1.68, Pb 0.05, Fe 25.06, SiO_2 23.33, and S 25.63%. Reagent consumption is high due to Cu. AHE (1e)

Gold Ore from Mikado Mine at Bag Bay, Shoal Lake, Lake of the Woods, Ontario. W. B. Timm *et al.* *Canada Department of Mines, Mines Branch Report* 744, 1934, pages 133-138. The average analysis of the ore was Au 0.78 and Ag 0.44 oz./ton. Max. recovery by amalgamation was 86.5% of the Au; by flotation 83.5%. Cyanidation recovered 95.5-98.7% of the Au. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

Production of Highly Pure Metals of High Melting Point Shows Unexpected High Plasticity (Reindarstellung hochschmelzender Metalle erweist unerwartet hohe Verformbarkeit). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 25, July 7, 1935, page 501. Résumé of Köster's paper on the "Importance of Physico-Chemistry in Metal Industry" as presented before Annual Meeting of Bunsen Society, May 31, 1935. The production of highly pure metals by decomposition of their carbonyls is outlined briefly. GN (2)

The Primary Reaction of Metallic Oxides with Solid Carbon. W. Baukloh & R. Durrer. *Carnegie Scholarship Memoirs, Iron & Steel Institute*, Vol. 23, 1934, pages 1-12. See *Metals & Alloys*, Vol. 6, July 1935, page MA 273L/1. CW (2)

2a. Non-Ferrous

Production of Silico-Aluminum Alloys Directly in Commercial Electrolytic Cells. A. I. Zheleznov & B. N. Maksimenko. *Legkie Metallui*, Vol. 4, Feb. 1935, pages 32-46. In Russian. Silico-Al containing 77% Si and 1.5% Fe can be added directly to the Al cell to produce alloys containing up to 20% Si. Production of alloys containing over 16% Si is difficult because Si enters the electrolyte and is lost and because the productivity of the cell decreases. Up to 16% Si the productivity of the cell, in terms of Al reduced, is not reduced by the addition of silico-Al. The consumption of cryolite and electrical energy is slightly increased. Silico-Al should be added in small portions from 14 to 2 hours before tapping the cell. The decomposition of the electrolyte must be constantly corrected by adding AlF_3. HWR (2a)

Heat Equilibrium in Electric Furnaces During Production of Aluminate Slags. P. B. Golubkov. *Legkie Metallui*, Vol. 4, Feb. 1935, pages 16-22. In Russian. In the production of aluminate slags in the electric furnaces at the Dnieper Aluminum Plant, considerable difficulty has been caused by the formation of accretions containing Ti, probably because the charge, consisting of CaO-Al_2O_3 agglomerate melts at the same or at lower temperature than the aluminate slags, thereby preventing superheating the slags sufficiently to dissolve the Ti compounds. By making the slag of eutectic composition and charging raw Al_2O_3 and CaO, the slag should be sufficiently superheated to dissolve the Ti accretions. HWR (2a)

Combined Alkaline Method for the Production of Alumina. V. A. Mazel. *Legkie Metallui*, Vol. 4, Feb. 1935, pages 22-31. In Russian. In the treatment of bauxites high in SiO_2 by the Bayer process, the residue from the NaOH treatment contains large amounts of Na_2O and Al_2O_3. This residue can be sintered with CaO and Na_2CO_3, the sinter leached with H_2O, and the two aluminate solutions combined. HWR (2a)

Refining of Magnesium (Magnesiumgewinning). Otto Kühle. *Metall und Erz*, Vol. 32, June 1935, pages 237-241. A review. CEM (2a)

The Production of Metals of the Cerium Group. Félix Trombe. *Transactions Electrochemical Society*, Vol. 66, 1934, pages 57-62. A miniature cell for fused chloride electrolysis was developed, capable of handling very small quantities of rare earth metal chlorides. With a purified C anode, a Mo rod cathode and a fluoride-porcelain cathode cup to catch the metal as formed, high purity Ce, La and Nd metal were produced which were spectroscopically free from Ca and Al and contained but very small percentages of Si and Fe present as impurities. The physical properties of these pure metals were determined. The metals are all very malleable and relatively soft. (2a)

Advances in Aluminum Metallurgy (Le progrès de la métallurgie de l'aluminium). Léon Guillet. *Genie Civil*, Vol. 106, Apr. 20, 1935, pages 382-384; Apr. 27, 1935, pages 401-406; May 4, 1935, pages 435-439; May 11, 1935, pages 454-457. An extended survey of the present status of the Al industry is given. Al ore reserves of the world are described. Al_2O_3 production methods are listed, including the less known methods, such as Peniakoff's, Serpek, Badin-Arnou, Blanc and Halvoen. Pedersen's process now is used commercially in Norway. It consists in fusing bauxite with Fe ore, coke and CaO in an electric furnace. Fe and Al-rich slag are produced. The latter is dissolved in $NaCO_3$ solution. The Aluminum Company of America melts bauxite with enough coke to reduce all impurities leaving Al_2O_3 unreduced. In Haglund process bauxite, coke and FeS are melted together. Al_2S_3 volatilizes and is decomposed by water. It is used at present in Germany, Italy and Switzerland. Electrolysis and production of electrodes and purification of the metal are described in detail. JDG (2a)

Certain Possible Industries for Washington Utilizing Grand Coulee Power. A. E. Drucker. *Metallurgical Research Bureau, State College of Washington, Information Circular* No. 10, June 18, 1935, 13 pages. Flow sheets for the production of (1) Al from clay and (2) Mg from magnesite are given. AHE (2a)

Electrolytic Production of Tungsten Metal from a Fused Phosphate Bath. Shoo-Tze & Tsing-Nang Shen. *Transactions Electrochemical Society*, Vol. 66, 1934, pages 461-469. The electrolytic production of W in a fused phosphate bath, originally suggested by Hartmann, was investigated. It was found that the current efficiency and energy efficiency could be much improved if the electrolysis were performed at a temperature higher than that suggested by Hartmann and when using a higher current density. A temperature of 900° C. and a current density of 35 amp./dm.² give the best result. The electrolyte giving the best current efficiency (88%) was that selected by Hartmann, namely 7 mols of $Na_4P_2O_7$, 3 mols of $NaPO_3$, and 7 mols of WO_3, but without addition of NaCl. The best energy efficiency was secured in an electrolyte containing 7 mols $Na_4P_2O_7$, 3 mols $NaPO_3$, 4 mols WO_3 and 15 mols NaCl. A yield of 469.9 g. W/kw-hr. was obtained. (2a)

Bismuth in Copper: Its Effects, Determination, and Some Experiments in Its Gaseous Elimination. C. O. Bannister & W. M. Doyle. *Bulletin of the Institution of Mining & Metallurgy*, No. 365, Feb. 1935, page 39. Discussion. See *Metals & Alloys*, Vol. 6, May 1935, page MA 178R/2. AHE (2a)

The Flin Flon Zinc Plant of the Hudson Bay Mining & Smelting Co., Limited. John D. Carr & M. K. T. Reikie. *Transactions Canadian Institute of Mining & Metallurgy, 1935 (in Canadian Mining & Metallurgical Bulletin* No. 279, July) pages 287-310. Zn concentrate is roasted and most of the S removed as SO_2. The calcine is leached with a weak H_2SO_4 solution. The solution is purified by agitation with Zn dust to remove Cu, Cd and Co, and then run to the electrolytic department. The residue from the first leach is leached with stronger acid. The resulting impure solution is sent to the first leach, where the impurities are precipitated. The plant operation is described. In starting up no H_2SO_4 was purchased, but the roast was controlled to give high SO_4 leached with H_2O, and electrolyzed to give the necessary acid circuit in 3 months. The close control of roasting, low fuel consumption, low operating costs, high extraction and sulphate control are features of the plant. The extra treatment of the purified solution by passing it through a mass of mossy Zn was an innovation; it has proved its worth in removing part of the remaining traces of impurities from the solution. Refiltration of the purified solution after cooling and storage was an addition that has tended toward better cell operation and a purer product. With aeration and quiet storage a considerable percentage of basic $ZnSO_4$ and Fe is precipitated from the solution, and this combs out As, Sb, etc. AHE (2a)

Recovery of Vanadium from Low-Vanadium Products (Beitrag zur Frage der Vanadium- Gewinnung aus Vanadium-armen Produkten). H. Pohl. *Metallwirtschaft*, Vol. 14, May 10, 1935, pages 367-368. Due to the affinity of V for O, separation of V from other metals can be effected by the addition of metallic oxides when the slag is either basic or acid. For instance, in smelting a Cu ore the V can be concentrated in the slag by addition of Fe_2O_3. CEM (2a)

2b. Ferrous

Theory of Blowing Blast Furnaces. M. P. Belikov. *Domez*, 1935, No. 1, pages 18-31; No. 2, pages 18-25. In Russian. A comprehensive study directed towards unification of all factors involved in blowing a blast furnace, from the characteristics of the blowing machine to the resistance of the furnace charge. It gives a connected picture of the phenomena taking place and illuminates all basic questions arising in daily practice. Particular attention is paid to corresponding advantages of individual and combined blowing. (2b)

Valuation of Iron Ores (Zur Bewertung von Eisenerzen). W. Luyken. *Mitteilungen aus dem Kaiser-Wilhelm Institut für Eisenforschung, Düsseldorf*, Vol. 17, No. 1, 1935, pages 1-18. See *Metals & Alloys*, Vol. 6, July 1935, page MA 273R/9. Ha (2b)

Checker Increases Stove Efficiency. A. Bowland. *Blast Furnace & Steel Plant*, Vol. 22, Dec. 1934, pages 695-697. Describes checker developed by William M. Bailey Co., Pittsburgh, Pa. MS (2b)

On the Manufacture of Low Phosphorus Pig at the Pen-hsi-hu Iron Works, South Manchuria. Bunzo Ido. *Tetsu-to-Hagane*, Vol. 21, Mar. 25, 1935, pages 143-164. At the Pen-hsi-hu Iron Works, there are 2 blast furnaces, with daily capacity of 200 tons each, from which various foundry, basic and low P pigs amounting to 150,000 tons/yr. are produced. To make low P pig, the P-poor concentrated ore and coal, 69% Fe, 1% SiO_2, 0.007% P, 0.009% S and 14% ash, 0.01% P, 0.45% S, respectively, are used in proper mixture in charge, and the furnace runs with a small quantity (30-35%/ton pig) of moderate basic slag and uses quite high temperature. Pig Fe which is as low in P, S, Cu and Si as is Swedish charcoal pig, and also Fe low in P and S, but high in Si and Mn are produced according to demand. The analysis of the first class, which is the main product, is as follows:—less than 0.025% P, less than 0.015% S, less than 0.015% Cu, more than 0.50% Mn, and more than 1.0% Si. All the low P pig is exported to Japan and mainly used in acid open hearths. The demand in Japan has increased rapidly in the last 2-3 years, especially in 1934, when its demand reached about 50,000 tons. In near future, 75,000 tons a year may be produced by further enlarging the works. TS (2b)

Production of Copper Steel at the Frunze Plant. S. Piskarev. *Stal*, Vol. 4, Nov.-Dec. 1934, pages 26-30. In Russian. Pyrite cinders (from a nearby H_2SO_4 plant) containing 50-55% Fe and 0.7-1.0% Cu are smelted in a blast furnace, and the resulting pig Fe is refined in an open hearth. The steel obtained contains 0.3-1.8% Cu, has good mechanical properties, and is not "hot short." Micro-analysis shows that all the Cu is in solid solution. The plant at present is being rebuilt and enlarged so as to operate almost entirely on these pyrite cinders. Sulphur analyses are not given. HWR (2b)

The Production of Sponge Iron from Moose Mountain Concentrate. W. B. Timm *et al. Canada Department of Mines, Mines Branch Report* No. 744, 1934, pages 174-180. The production of an exceptionally high-grade sponge Fe from —300 mesh Moose Mt. concentrate is technically simple. The material is sintered because good reduction is difficult with very fine material and briquetting of the finely divided sponge Fe is difficult, if not impossible. The sinter, analyzing Fe 71.05, insoluble 1.47, P 0.015 and S 0.010%, was metallized with charcoal to give a sponge Fe analyzing total Fe 95.20, metallic Fe 94.50, insoluble 2.89, P 0.020, S 0.030 and C 0.24%. The sponge from gas reduction was similar except that C was 1.99%. The sponge Fe briquets were converted by heating and working into wrought Fe. Physical data on the product are given. AHE (2b)

3. MELTING, REFINING AND CASTING

A New Multi-Casting Process. René Leonardt. *Foundry Trade Journal*, Vol. 52, June 13, 1935, pages 397-398. A new type of squeeze machine has been designed which is operated by compressed air and with which the squeezing is effected automatically. The impression of the top and bottom pattern-plate is effected by means of a piston which carries the bottom pattern-plate and which moves upward and presses against a fixed presser head carrying the top pattern-plate. When molding deep and sharp castings the machine can also be used as a stripping-plate molding machine. The machine is built in 3 sizes; stationary and portable. It is capable of taking flasks from 248 to 558 in.² and generally works with a pressure of 6 atmospheres. The machine permits the insertion of an electric heating plate in the table to prevent the sand from adhering to the pattern in cold or damp weather. AIK (3)

Use of the Pipette Method in the Fineness Test of Moulding Sand. Clarence E. Jackson & C. M. Saeger, Jr. *Foundry Trade Journal*, Vol. 52, June 20, 1935, pages 409-410. See *Metals & Alloys*, Vol. 6, June 1935, page MA 222L/5. AIK (3)

The Control of Mould Drying Processes. V. Aronovitch. *Foundry Trade Journal*, Vol. 52, June 13, 1935, pages 393-396. The main feature of the new method of drying molds and cores is that the control is performed during the actual drying process without any damage to the molds or cores under control. The principle of the new method consists in measuring the electric conductivity of the molds and cores during the actual drying period. The control procedure consists in inserting 2 resistance couples into the green mold or core and measuring the conductivity during the drying period. For oil-sand cores, the basic principle of which consists of oil oxidation, the water being only an auxiliary medium for oil distribution, this control method may not be suitable. Control procedure, resistance couples, insertion of couples into mold and core, practical accuracy of control method etc. are discussed. Paper is illustrated by a number of diagrams. AIK (3)

3a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Electrolytic Refining of Raw Silver Containing Palladium (Die elektrolytische Raffination von palladiumhaltigem Rohsilber). G. Hänsel. *Metall und Erz*, Vol. 32, Apr. 1935, pages 161-163. Attempts were made to separate and recover Pd from Ag during its electrolysis, using several compositions of anodes and solutions. Some Pd always dissolves at the anode and when the concentration in the electrolyte becomes sufficiently high it deposits with the Ag at the cathode. The amount of Pd dissolving increases with increasing Au content in the anodes and increasing HNO_3 content of the electrolyte. Deposition of Pd at the cathode can be prevented by precipitating it in a weakly acid electrolyte, .4% HNO_3, with dimethylglyoxime. The Pd can be recovered from the anode mud. CEM (3a)

Volatilization in Metallurgical Processes (Der Verdampfungsvorgang bei metallurgischen Arbeiten). W. Leitgebel. *Metall und Erz*, Vol. 32, May 1935, pages 205-211. In one type of process gaseous metals or compounds are formed by reactions, as example, when Zn or ZnO are volatilized from ores and alloys. No outside source of gas or air is necessary. A second type is volatilization at the boiling point. Pressure-temperature relationships are discussed. A metal can be volatilized below its normal boiling point by reducing the pressure. The boiling point is raised by addition of another metal. Zn can be separated from a Zn-Pb alloy by distillation. Zn and Cd distill together and separation by this method is not practical. For separation of 2 metals to be practical they must have suitable vapor pressure and boiling point curves without maxima and minima. In volatilization by convection air is used to remove the gases formed. Oxidation usually takes place also. This process is used to volatilize lead oxide, also As, Pb and Cd from zinc-blende, and Zn from bronze scrap. An example of volatilization in a converter is the blowing of scrap brass to remove Zn, Pb and Sn. In the converter the process is a combination of reaction, boiling, and convection. 30 references. CEM (3a)

Deoxidation of Bronzes by Phosphorus. Hideo Nishimura. *Suiyokwai-Shi*, Vol. 8, Aug. 1935, pages 751-762. In Japanese. The oxide contents in Cu and bronzes was estimated by H-reduction method, and it is concluded that the reduction should be made for 4 hours at 900° C. SnO_2 in bronzes may be determined by the same method as used for CuO_2 in Cu. Industrial bronzes do not contain more than 0.3% SnO_2 and usually about 0.1%. When an oxidized bronze is deoxidized with P, a certain amount of P always remains in bronze, according to the equilibrium relation: $SnO_2 + P \rightleftarrows Sn + P_2O_5$. Deoxidation with P should be carried out before the addition of Sn. Theoretical consideration of the principles involved explains the reason. HN (3a)

Controlled Casting. David W. Phillips. *Journal American Dental Association*, Vol. 22, Mar. 1935, pages 439-451. Three methods of compensating for the shrinkage of dental castings are discussed: (1) Expansion of the wax pattern by heating the investment to a certain temperature with a water bath; (2) Using the setting expansion of the investment in conjunction with the water bath; and (3) Varying the composition of the investment, i.e., the relative amount of cristobalite-containing investment and "expansion control powder." The author describes an automatic machine designed to deliver an investment of the proper composition for investing at any room temperature from 60° to 110° F. to compensate for the casting shrinkage (1.25%). The mold-temperature range recommended for this procedure is 1100° to 1500° F. OEH (3a)

Unsoundness in Aluminium Sand Castings. D. Hanson & I. G. Slater. *Foundry Trade Journal*, Vol. 52, Mar. 14, 1935, pages 185-186, 189. See *Metals & Alloys*, Vol. 6, July 1935, page MA 276R/6. AIK (3a)

Physical Chemistry of the Steelmaking Process (Physikalische Chemie der Eisenhüttenprozesse. II). H. Schenck. Julius Springer Verlag, Berlin, 1934. Cloth 7 x 10 inches, 274 pages. Price 28.50 RM.

The second volume of Schenck's "Physical Chemistry of the Steelmaking Process" should be of interest to all metallurgists and operators in the open hearth and Bessemer field.

The book covers the physico-chemical principles involved with the help of a sufficient number of diagrams so that even those who cannot readily read German may grasp many of the data presented and the conclusions drawn therefrom.

If there is any criticism of the book it would appear that many of the final conclusions regarding (1) the oxidizing power of basic slags and (2) some of the deoxidation constants, may have been the result of too many assumptions in the same calculation. However, with regard to the conclusions on basic slags, it would appear that everyone who has had to deal with these has had recourse to the same method, be he a physical chemist, a metallurgist or a petrographist.

The first section of the book deals with a brief description of the methods used in presenting data and a discussion of methods of measuring temperatures. Some of these methods are well worth trying out and might well be reported on by American investigators.

The second, and perhaps most interesting, section deals with slags and the activity of the various components therein. The method of obtaining active lime and active oxide in the slag are described in detail, and the possible compounds present are discussed from many points of view. The painstaking work involved in the calculation of the charts in this section is worthy of especial comment. The amount of free oxide in basic open hearth slags is somewhat lower by the author's method than that given by investigators in this country but the general principles of slag composition are the same, increasing basicity lowers the percentage of active oxide by the formation of calcium ferrite.

The influence of carbon on the oxygen content of steel is set forth in section three. Schenck's conclusions on this reaction are based on his particular way of using the aluminum method for determining oxygen in steel. Inasmuch as his technique gives considerably lower oxygen values than those obtained by the original investigators, his constants for the reaction are likewise lower. It is worthwhile noting that the most recent American work on this reaction indicates that Schenck's method for oxygen must give low results. The Bessemer process is given considerable space in this section, and in view of the lack of published information in American journals on this subject, this part should be of great interest to our various Bessemer operators.

The fourth section, on manganese and silicon is devoted to the behavior of these elements in the open hearth, acid and basic, electric and Bessemer processes. The constitution of acid and basic slags is given further space with respect to the compounds containing MnO and SiO_2. Methods of calculating residual manganese and silicon from slag analysis and charge composition are included with many charts showing the effect of varying the compositions and temperature.

Phosphorus elimination is discussed in section five and it is shown that the P_2O_5, the "active oxide," the "active lime," and the temperature are the controlling factors in the elimination of phosphorus. In the discussion of sulphur in the sixth section the effects of slag composition, sulphur in the charge and sulphur in the fuel are discussed. It is also stated that a high manganese content in the slag favors desulphurization, a statement which cannot be readily proven in American practice.

The section, seventh, on the oxygen content of steel, reviews very briefly the effect of "free oxide" on the steel and goes at some length into a description of the carbon reaction as indicative of the oxidation of the metal bath, in which the author is a firm believer.

Section eight on the deoxidation of steel summarizes the various equilibrium constants involved in deoxidation with manganese, silicon and aluminum and presents the results in the form of charts and equations. This section is much stronger on the theory and determination of the equilibria involved than in the practical problems of deoxidation.

The last section deals with gases in steel and includes data which will certainly be new to many interested in producing steel with a minimum of controlled gas content. The factors affecting the evolution of CO are considered in the light of equilibrium and the effect of manganese is shown. This section contains many interesting data and conclusions.

It is to be regretted that the book does not contain more information on steel in ingot form. It is to be hoped that the preparation of a third volume describing the ingot and steel rolled from it, is on the author's list of "things to do next." C. H. Herty, Jr. (3a)-B-

Production of Powdered Alloys of Low Melting Point. R. W. Rees. *Journal Institute of Metals*, Vol. 57, June 1935, pages 335-337 (Advance Copy No. 708). A Pb-Cd-Sn alloy with a freezing range from 180° to 150° C. was used. While in the pasty condition the metal was put through an impeller-type disintegrator maintained at a temperature about 10° C. below the solidus. JLG (3a)

Controlled Hygroscopic Expansion of Investment to Compensate for Shrinkage in Inlay Casting. C. H. Scheu. *Journal American Dental Association*, Vol. 22, Mar. 1935, pages 452-455. Dental investments (plaster of Paris and cristobalite) were found to expand if they were supplied with moisture during setting, and the amount of expansion to depend upon the stage in setting and the amount of moisture supplied. A technique for compensating for the shrinkage of gold castings has been developed on this principle. The investment ring may be lined with wet asbestos, which will later supply the moisture, or dry asbestos may be used, and then after the investemnt has been set about 15 min. it is immersed in water for 20 to 30 min. Immersing in water in less than 15 min. increases the expansion, while a longer setting time decreases the expansion. The author recommends 800° F. mold temperature for most castings, but suggests a dull red temperature for full crowns. OEH (3a)

Where Product Effectiveness Is Based on Die Castings. Herbert Chase. *Electrical Manufacturing*, Vol. 15, May 1935, pages 63-66. General discussion of various products made in die casting machines. Small parts in sections of less than .020" thickness have been successfully die cast. WB (3a)

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1 **Pouring Ingots of Aluminum Rolling Alloys with Special Regard to the Question of Molds (Das Giessen von Blöcken aus Aluminiumwalzlegierungen mit besonderer Berücksichtigung der Kokillenfrage).** A. v. Zeerleder. *Metallwirtschaft*, Vol. 14, July 12, 1935, pages 545-548. Ingots of pure Al and Al alloys for rolling, pressing and forging must have a smooth surface, fine grain and be free from internal shrinkage and segregation. Close grained pearlitic cast iron, sometimes cast with chills, has been found to be the best ingot mold material. The molds should be thoroughly annealed at 800°-900° C. before using. To prevent hot cracks they should be coated with a mixture of clay and sodium silicate. The molds are preheated, the temperature depending on the alloy, varying from 100° for duralumin to 500° for high purity Al. With the higher mold temperatures solidification is slower and internal shrinkage prevented, but the metal becomes coarse grained and is liable to segregate. With increasing alloy content the mold temperatures are kept lower to prevent segregation. The molds are usually tilted at the start of pouring and are gradually righted to keep the metal as quiet as possible and prevent inclusion of oxides. On account of the high shrinkage the ingots must be carefully filled during solidification. Several types of special molds have been used which can be filled without tilting and without disturbing the metal. Molds with cooling arrangements have not been generally adopted. Cast iron molds, weighing 8 times as much as the ingot, absorb the heat with a 100° temperature rise. Fine grain size can be obtained by the addition of .1 to .2% Ti and by rapid solidification. Small shrinks weld together during rolling, but large shrinks must be avoided. Segregation takes place especially in the Cu alloys, the surface of the ingot usually being higher in alloy content. One method of overcoming segregation is the casting of round ingots and pressing them flat before rolling. 7 references. CEM (3a)

2 **Application of the Electric Resistance Furnace in the Melting of Light Alloys (L'Application du Four Electrique à Résistance à la Fusion des Alliages Légers).** *Electricité (Science et Industrie)*, Vol. 19, Apr. 1935, page 155. General article. FR (3a)

3 **Observations of the Porosity and Segregation of Two Bronze Ingots.** N. P. Allen & S. M. Puddephat. *Journal Institute of Metals*, Vol. 57, May 1935, pages 211-220 (Advance Copy No. 701). One ingot weighing 28 lb. was cast in a big-end-up mold and the other, of the same weight, was cast in a mold with the big end down. The bronze contained 10% Sn. Ingots were sectioned vertically and the density and composition at different points in the plane of section determined. Results indicated that the distribution of cavities and Cu is determined by the flow of heat away from the casting. The parts of the ingot that solidify last are more porous and richer in Cu. Both distributions are explicable on the assumption that during solidification a liquid rich in Sn travels towards the outside of the ingot. JLG (3a)

4 **Porosity in Leaded Bronze Bushings.** A. W. Lorenz. *Transactions American Foundrymen's Association*, Vol. 6, Apr. 1935, pages 311-322. Porosity in cast products generally occurs as gas or blow holes or as shrinkage voids. One of the most common causes of blow holes is cold metal. Another cause is entrapment of gases due to the metal flow within the mold. Experiments were conducted to determine how metal flow affected the porosity of a certain type of large bushing with which the foundry was having trouble. The results of that investigation showed that improper gating was the cause of the trouble. Experiments on mold washes were conducted and it was concluded that mold washes tend to promote porosity in heavy castings made from the type of metal under consideration. After careful investigation, is was found that over 1 oz. of phosphor-copper or 1 lb. of Zn/100 lbs. of melt was sufficient to produce undesirable shrinkage in heavy sections of an alloy containing 80% Cu, 7% Sn, and 13% Pb. The author is of the opinion that the majority of shrinkage trouble is due to "over-reduced" metal. CEJ (3a)

5 **Fabrication and Uses of Magnesium Alloys.** A. W. Winston. *Iron Age*, Vol. 135, Mar. 7, 1935, pages 12-16. Describes the manufacture of sand and die castings extruded shapes, forgings and sheet from Mg alloys. Also deals with special treatment given surface of metal and method of painting to insure most satisfactory results in service. In manufacture the Mg and alloying elements are melted together, either protected by a flux in open or in closed pot with an inert atmosphere to prevent oxidation. The alloys are cast either in dry or green sand molds. Includes a table giving the chemical composition and uses of Docometal alloys. VSP (3a)

6 **Aluminum Used for Casting Statuary.** *Iron Age*, Vol. 135, May 9, 1935, pages 14-15, 102. Gives some historical data on Al statuary and describes the "lost wax" process of casting small objects, and procedure followed in casting the Navy and Marine memorial. VSP (3a)

7 **Aluminum Casting in Sand and Chill Molds (Aluminiumguss in Sand und Kokille).** Roland Irmann. Akademische Verlagsgesellschaft, Leipzig, 1935. Cardboard, 6¼ x 9 inches, 119 pages. Price 6.80 RM. This book of slightly over 100 pages, with 70 diagrams and illustrations, has been written with the object of giving the foundryman, familiar with the casting of other metals, a general view of the casting of aluminum alloys in sand and chill molds. The treatment of general subjects like alloys, alloying, and the finishing of castings by polishing, sand-blasting, surface treatment, etc., is very brief. The book, however, contains interesting and well-illustrated chapters on casting in sand and chill molds. The author's association with Aluminium Industrie, A.G., Neuhausen, has enabled him to use many excellent illustrations which add to the value of the book
Junius D. Edwards (3a)—B—

8 **Beryllium and Its Production.** *Canadian Chemistry & Metallurgy*, Vol. 19, Aug. 1935, pages 226, 228. The electrolytic production of Be is discussed. Pure Be can be melted in a vacuum and cast into ingot form. Lowering of the cost of production will increase the number of uses for Be. WHB (3a)

9 **Elektron Die Casting (Elektronmetallspritzguss).** A. Bauer. *Technisches Zentralblatt für praktische Metallbearbeitung*, Vol. 45, Mar. 1935, pages 90-92; Apr. 1935, pages 150-152. Discusses evolution of the elektron die casting process, casting machine, physical properties of elektron, wall sizes and shrinkage, size limitations for elektron die castings, special physical properties of elektron die cast material such as low specific weight, favorable working properties, corrosion resistance, economy and utilization. WH (3a)

10

3b. Ferrous

C. H. HERTY, SECTION EDITOR

Deoxidation with 45% Ferro-Silicon in a Basic Open Hearth Furnace. P. KRAVTZOV & S. SAPIRO. *Stal*, Vol. 4, Nov.-Dec. 1934, pages 31-44. In Russian. In the production of 1.7% Si spring steel, 45% Fe Si was successfully substituted for 75% Fe Si. Since the large amount of 45% Fe Si needed would cool the steel too much if added in the ladle, 40% of it was added in the furnace. The addition of Fe Si in the furnace does not hinder dephosphorization, injure the furnace hearth, nor lower the mechanical properties of the steel. Volatilization of Si is constant and equals about 25%. HWR (3b)

Centrifugally Cast Cast Iron Tubes (Les Tuyaux en Fonte centrifuges). DELCROISETTE. *Revue de Fonderie Moderne*, Vol. 29, May 10, 1935, pages 152-156. The present status of centrifugal casting is reviewed and kind and position of molds in the different processes, manner of introducing the molten cast Fe into the mold, of taking the tube from the mold, and annealing methods are discussed. Ha (3b)

Production of High-Grade Cast Iron in Cupola Connected with a Rotary Furnace (Die Erzeugung von hochwertigem Gusseisen im Kupolofen mit angebautem Trommelofen). *Feuerungstechnik*, Vol. 22, Mar. 15, 1934, page 37. Describes a construction which aims at combining the advantages of the cupola and an oil-fired rotating furnace, i.e. respectively the cheap melting method and the production of a better grade of cast Fe. After leaving the cupola, the Fe passes a stationary hearth which holds back the slag and a second chamber and then enters the oil or gas fired rotary or oscillating furnace where the partial desulphurization takes place. WH (3b)

Slag Control in the Making of Iron and Steel. *Metals Technology*, June 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 625, 43 pages. This includes papers and discussions at the symposium held at the Fall meeting of the Iron & Steel Division, Oct. 4, 1934. Much of the material has been condensed. The individual papers included are: **Slag Control and the Blast Furnace,** RALPH H. SWEETSER; **Slag Control in Rimming Steel,** L. F. REINARTZ; **Slag Control Applied to Low-Carbon Steel,** FRANK G. NORRIS; **Slag Control for Basic Open-hearth High-carbon Steel,** W. J. REGAN; **Slag Control for Recarburized Rail Steel,** A. P. MILLER & T. S. WASHBURN; **Slag Control for Alloy Forging Steel,** A. L. FEILD; **Slag Control for Alloy Forging Steel,** R. C. GOOD; **Slag Control for Acid Open-hearth Steel,** FRANCIS B. FOLEY; **Slag Control for Basic Electric-furnace Steel,** H. F. WALTHER; **Physical Testing of Slag,** A. B. KINZEL. JLG (3b)

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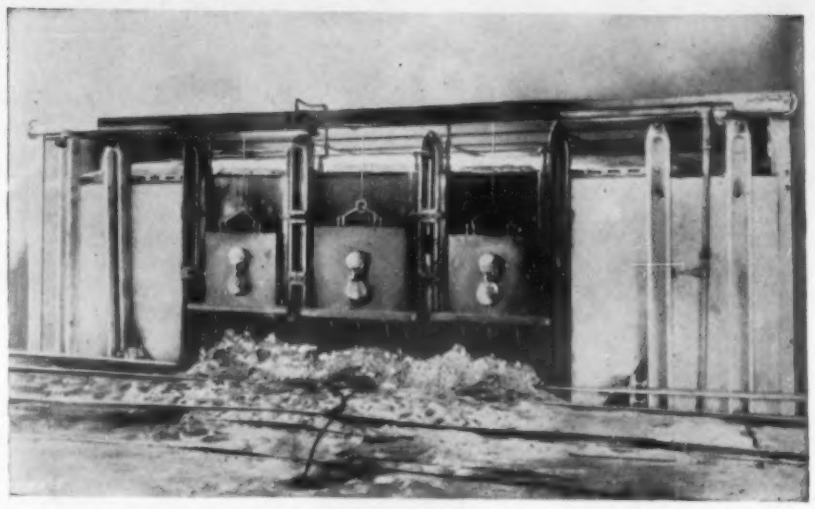

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A New Foundry Product. A. B. Everest. *Foundry Trade Journal*, Vol. 52, Apr. 25, 1934, pages 279, 280. Paper presented to London Branch of Institute of British Foundrymen. It deals with development of alloy-steel permanent magnets. W steel was almost universally employed for the better class magnets up to the time of the Great War. In 1915 Co steel containing 3, 9, 15 or 36% Co was invented. In 1930 Mishima developed the Ni-Al magnet steels. Quite recently it was found that by adding Co to the Mishima steels even better properties could be obtained. The new magnetic alloys are extremely hard and are quite unworkable, so that they are used exclusively in the cast form. AIK (3b)

Behavior of Fluorspar in Open Hearth Slag (Das Verhalten des Flusspats in Siemens-Martin Schlacke). E. Diepschlag & E. Brennecke. *Feuerungstechnik*, Vol. 22, June 15, 1934, pages 65-70. The effect of various additions of CaF_2 to acid and basic slags was studied at 1500° C. with respect to 90 minutes heatings. Fluorspar does not react with lime and alumina. It improves the fluidity of basic slag and reduces the softening interval. The softening point of acid slags is shifted to much higher temperatures by CaF_2. SiO_2 causes considerable CaF_2 losses due to the formation of volatile SiF_4 according to: $2\ CaF_2 + 3\ SiO_2 = 2\ CaO\ (SiO_2) + SiF_4$. These losses are counteracted by lime: $CaF_2 + SiF_4 = CaSiF_6$ and $CaSiF_6 + 3\ CaO = 3\ CaF_2 + CaSiO_3$. Some F is lost due to the presence of H_2O in the furnace atmosphere due to the formation of HF: $CaF_2 + H_2O = CaO + 2\ HF$. The favorable effect of CaF_2 on the S content is not exclusively due to chemical reaction (oxidation of sulphides) but also due to the formation of a more fluid slag. EF (3b)

Notes on Pipe Formation and Shrinking (Note sul Risucchio e sul Ritiro). M. Barigozzi. *Industria Meccanica*, Vol. 17, June 1935, pages 519-525. From a review of literature on piping in castings the author concludes that pipes will not form when the change of volume and cooling take place in parallel layers and isothermically and by filling up the cavity as it forms. The cavity depends on the change in volume from the time after pouring has ceased to the time of complete solidification. The effect of Si and S on shrinkage of cast Fe and the relation of shrinkage to pipe formation is discussed. Ha (3b)

A New Electric Furnace Technique: The Use of Barium Flux. M. A. Baernstein. *Transactions Electrochemical Society*, Vol. 66, 1934, pages 323-328. Experiments were carried out in the Detroit rocking furnace with various ferrous metal heats. It was found that the addition of a mixture of Ba oxide and Ba carbonate, about ½ hour before pouring, not only improves the metal product but adds greatly to the life of the acid lining of the furnace. Finally, it has been observed that the presence of barium compounds in the furnace resulted in a quieter and steadier arc. (3b)

New Equipment in Buick Foundry Improves Quantity, Quality and Working Conditions. *Automotive Industries*, Vol. 73, July 20, 1935, pages 78-81. A description with illustrations is given of the modern equipment and procedure used in making 500 tons of iron alloy automotive castings each 9 hour day. A battery of externally located oil fired indirect recirculating air heaters are used for heating the continuous core drying ovens. Core blowing machines are widely used. A slag conveyor carries molten slag direct from the cupola to a bin outside the building where it is granulated. Greater mechanization and better control is said to result in making a superior product with less rejects and the elimination of some of the more laborious tasks. BWG (3b)

Complex Foundry Problems. S. Carter. *Foundry Trade Journal*, Vol. 52, Apr. 18, 1935, pages 267-269. This paper was read before the West Riding Branch of the Institute of British Foundrymen. The cupola, coke-to-iron ratios, stocking iron, coal-dust experiments, heavy sections and small cores are discussed. AIK (3b)

Foundry Graphite (La piombaggine adoperata in fonderia). C. Cibulca. *La Fonderia*, Vol. 10, Jan. 1935, pages 33-37; Feb. 1935, pages 77-82. Discusses use of graphite in foundry practice and properties it should possess. The fundamental property, a high resistance to pouring temperatures, depends on the amount of graphitic C, size of the original graphitic crystals and the composition of the accompanying materials. Therefore the prerequisites for a good foundry graphite are; highest possible graphitic C content which should be reduced to a finely powdered condition, minimum combustible S content, ash-forming materials which have high fusion points. The ash-forming constituents exercise considerable influence on the quality of the castings, particularly the Al silicates. JO (3b)

The High Test Iron Foundry. V. A. Crosby. *Canadian Chemistry & Metallurgy*, Vol. 19, July 1935, pages 199-200, 202. High test cast iron includes those having tensile strength in excess of 40,000 lbs. /in.². The various types of furnaces for its production are briefly described. Included are: the Lanz process, the Thyssen-Emmel process, the Wust furnace, the Corsalli-, the Deschane- and the Meehanite processes. WHB (3b)

Co-ordinators Report on Scrap Made Public. *Railway Age*, Vol. 99, July 1, 1935, pages 13-16. Costs of handling scrap on various railroads is shown in several graphs, costs of dismantling obsolescent equipment also shown in graphs, discussion and conclusions. WB (3b)

Metallurgical and Metallographic Basis for Production of Chilled Rolls. V. N. Svechnikov. *Domez*, No. 3, 1935, pages 23-33. In Russian. A summary of data published in the literature bearing on the features connected with the production of chilled rolls. (3b)

Sulphur in Steel and Cast Iron (Le Soufre dans les Aciers et les Fontes). H. Thyssen & W. Bonhomme. *Revue Universelle des Mines*, Vol. 11, July 1935, pages 316-325. The harmfulness of S and the methods to reduce its amount in metallurgical processes as much as possible are discussed, and the constitutional diagrams of the systems Fe-C-S, Fe-FeS-Mn-MnS and Fe-Fe_3C-FeS-Mn explained. From these diagrams desulphurization by Mn is explained as follows: the content of Mn must be sufficiently above the plane of the ternary eutectic if formation of FeS is to be prevented. At 1320° C. there exist (1) a mother liquid of low Mn content, (2) a liquid rich in S and Mn, and (3) some austenite dendrites depending on the C content. In cooling, liquid (2) reacts with (1) and Fe-Mn crystals rich in Mn and MnS-FeS crystals are formed. The Mn rich crystals dissolve in liquid (1) increasing the Mn content of the latter and thus favoring subsequent desulphurization. 6 references. Ha (3b)

Essentials in the Production of Sound Steel Castings. J. S. Bennett. *Foundry Trade Journal*, Vol. 52, Apr. 11, 1935, pages 253, 256. The methods of feeding, sands in the ordinary foundry, unrestricted contraction and heat treatment are discussed. If the analysis be correct, the author states, there is never any need to use expensive alloys for cleaning metal. Even from Bessemer the metal can be efficiently deoxidised by the usual ferro-silicon and ferro-manganese additions to the bath, with perhaps a small addition of Al to the stream of molten metal as the ladle is being filled. Pyrometric control of casting temperatures is rarely of any real advantage. There are so many variable factors, other than the temperature of the metal, which affect the fluidity that, to an experienced eye, the appearance of the metal is a more accurate guide AIK (3b)

Cupola Practice and Carbon Control. W. H. Bamford. *Foundry Trade Journal*, Vol. 52, Mar. 7, 1935, pages 169-172. Paper read before the Birmingham and West Midlands branch of the Institute of British Foundrymen. The author gives some details of experiences with semi-steel made in cupola as it has been found that, by suitably balancing the charges it is possible to obtain an iron of almost any C content desired, keeping it to within as close limits as those obtained from electric furnace, and far more cheaply. The quantity and quality of the coke used are the all important factors which govern the absorption of C in melting, which in turn has a direct influence upon the hardness, fluidity and consequently the soundness of the iron at any particular time of melting. Cupola preparation, charging details, melting troubles, factors influencing C control, steel scrap selection, control by Keep's test, etc., are discussed. AIK (3b)

Production of Enameling Gray Cast Iron (Die Herstellung von emaillierfähigem Grauguss). *Giessereipraxis*, Vol. 56, July 7, 1935, pages 277-279. Stresses the following points of importance in manufacturing gray cast Fe for enameled products: (1) surface cleanness of casting, (2) proper composition of moldings and, the S content of the powdered coal used should be as low as possible and not surpass 1-1.2%, since powdered coal with S contents of 2-2.2% considerably decreases the output of sound parts, (3) proper composition of Fe applied; best is a metal containing about 2.8% Si, .6% Mn, .7-.8% P, .07-.08% S. The metal should be superheated and desulphurized, (4) proper cleaning of casting. GN (3b)

Making the Mold of a Valve Casing with Oval Flange (Herstellung der Form für eine Absperrschiebergehäusehaube mit ovalem Flansch). *Giessereipraxis*, Vol. 56, July 21, 1935, pages 309-311. The procedure followed in making the mold of this part is considered in detail. GN (3b)

Development of Foundry Technique by Means of Official Statistics (Die Entwicklung des Giessereiwesens an Hand einer amtlichen Statistik). *Giesserei*, Vol. 22, July 5, 1935, pages 340-341. The number of patents and trade marks pertaining to foundry technique applied for and granted by the German Patent Office since 1923 is taken as indicator. Ha (3b)

Describes Alternative Methods for Drum Cores. *Foundry*, Vol. 63, June 1935, pages 56, 58. Mold for drum casting may be made in green or dry sand, or loam. If only one casting is made mold can be made in green sand or a skin dried mold either in floor or in Fe flask. Where a number of castings are needed a dry sand or loam mold may be used repeatedly with little patching. When loam is used the inside of flask is bricked. Core might be made either by leaving one set of ribs in sand until dried core is removed or making core in inverted position, removing ribs from exposed part and filling spaces with black sand. A satisfactory method in making core is in halves. Gives method of procedure. VSP (3b)

Improvements on Converter Bottoms in the Thomas Steel Plant (Verbesserungen an Konverterböden im Thomas- Stahlwerk). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 25, July 7, 1935, page 497. Paper briefly describes a number of methods applied to increase the durability of converter bottoms and increasing the efficiency of the basic Bessemer Process, as (1) application of steel nozzles in the blast holes, (2) application of air cooled metallic bottoms, (3) application of a turbulent air current upon blowing, (4) oblique arrangement of the blast holes to decrease converter waste, (5) methods of injecting ore, limestone etc., through the bottom. GN (3b)

Hydro-Mechanism of the Bessemer-Converter with Reference to the Wear of its Lining (Zur Hydromechanik des Bessemer-Konverters in Zusammenhang mit dem Abnutzen seines feuerfesten Futters). B. J. Pines. *Physikalische Zeitschrift der Sowjetunion*, Vol. 7, No. 2, 1935, pages 189-212. In German. The velocity distribution in the blown Bessemer charge (metal and slag) in relation to the design of the converter bottom has been studied experimentally and analyzed mathematically. It has been proved that the velocity distribution is connected closely with the wear of the converter lining. The wear is solely attributed to mechanical action, i.e. to erosion. Conclusions are set forth from the derived formulae with the object of extending the service times of Bessemer linings by changing the design of the Bessemer bottom. 20 illustrations are included to demonstrate the currents in small converter models filled with colored alcohol, castor oil and mercury and blown with compressed air through the bottom. EF (3b)

The Occurrence and Determination of Oxygen in Steel. W. W. Stevenson. *Industrial Chemist*, Vol. 11, June 1935, pages 235-239. 23 references. 5 methods of determining oxygen in steel are discussed critically and the author's experiences with each method are given. RAW (3b)

Contemporary Methods for Making Certain Types of Stainless Steels in Basic Electric Arc Furnaces of Heroult Type. Y. A. Schultz. *Domez*, No. 3, 1935, pages 13-23. In Russian. On the basis of theoretical considerations and practical experience the boiling period has the greatest influence on soundness and deoxidation of Cr-Ni steels of 18-8 type containing 0.12-0.14% C. Slag must be kept more than 65% basic to prevent retention by it of MnO. FeMn must be continuously added to control the rate of C elimination, at the beginning as C containing alloy, at the end as C free. The shape of C elimination curve has a basic influence on the quality of the metal. Limiting curves are given within which the quality of metal produced remains satisfactory, both for straight and Ti bearing 18-8. Every phase of the processes is treated in detail and complete melting sheets are given. (3b)

Blast Supply Through Small Nozzles into the Shaft of Cupola Furnaces Above the Melting Zone (Windzuführung durch kleine Düsen in den Schacht von Kupolöfen oberhalb der Schmelzzone). CARL REIN. *Giesserei*, Vol. 22, July 5, 1935, pages 335-339. The efforts recently made to improve the combustion of coke in the cupola furnace by arranging air nozzles above the melting zone are discussed with regard to their practical value. It is concluded that such nozzles are of no use; the cupola process does not reduce CO_2 to CO as often assumed, all CO originates simply from incomplete combustion. The main object will always be to obtain as complete a combustion as possible by correct pressure and direction of the blast into the interior. The old slogan of foundrymen: Hot melting and cool casting! is still considered to be best practice; at least 1450° C. must be reached in melting but is no longer required at the taphole. Ha (3b)

Some Notes on Ingot Molds. T. SWINDEN & G. R. BOLSOVER. *Iron & Coal Trades Review*, Vol. 131, July 12, 1935, pages 44-46. The importance of composition of ingot molds with regard to their cost and life is discussed. It seems, however, from practical experience that the structure and uniformity of the material is of greater importance than chemical composition; an often used Fe is 3.5-3.75% total C, 0.3-0.6% combined C, 0.6-1.0% Mn, 1.9-2.3% Si, 0.03-0.05% S, 0.03-0.045% P. Alloyed cast Fe molds contain from 0.5 to 1.25% Cr; Ni showed no advantage, but higher Mn content seems to be advantageous for longer life. Design, shape, mold facings and failures through cracking are discussed. Ha (3b)

Influence of Making High Quality Metals on the Yield of Open Hearth Furnaces. M. A. TATAROV. *Domez*, No. 3, 1935, pages 3-13. In Russian. The opinion that quality steels require longer time for making was checked on the plant scale and reported in detail. None of the types of steel made in the plant investigated required a longer time for making than common rimming steel, as far as open hearth practice was concerned. (3b)

Viscosity and Plasticity of Disperse Systems. IV. Investigation of the Plastic-Viscous Properties of Molten Slags and Rocks (Über die Viskosität und Plastizität der plastisch-viskosen Eigenschaften geschmolzener Schlacken und Gesteine). M. WOLAROWITSCH. *Kolloid Zeitschrift*, Vol. 71, May 1935, pages 159-165. The significance of the viscosity of slags in metallurgical operations is pointed out. The rotating (Pt-Ir) cylinder apparatus according to Wolarowitsch was employed for the determination of the viscosities of molten slags and rocks up to temperatures of 1400° C. A comparison with similar tests of McCaffery & Field (Bureau of Mines, Technical Papers 157, (1916), 187 (1918), 189 (1919)) on slags of the CaO-Al_2O_3-SiO_2 system showed good agreement at elevated temperatures (low viscosity). At lower temperatures (high viscosity) a material difference between the experimental results was noticed. The author attributes this to a gliding effect of the slag at the graphite wall of the testing apparatus of the American investigators, a phenomenon also found by Herty and co-workers. Apparently graphite becomes oxidized by the slag with the liberation of CO. The use of a square graphite stirring rod minimizes but does not eliminate this source of error. The viscosity data are thus too low as compared with the results obtained in a noble metal apparatus. A number of Ti-slags have also been studied. The course of the viscosity curves changes materially at low temperatures, which effect is ascribed to the crystallization of the slags. EF (3b)

The Current-Conducting Properties of Slags in Electric Furnaces. Part II. AXEL WEJNARTH. *Transactions Electrochemical Society*, Vol. 66, 1934, pages 329-343. In this second part of the research, complex Mn-Al-Ca-Fe silicates were investigated. The close control of slag composition, depth and temperature in electrometallurgical operations is emphasized. (3b)

Operation of Electric Furnaces (Au sujet de la conduite des fours électriques). MARCEL GUÉDRAS. *Metaux*, Vol. 10, Jan. 1935, pages 22-25. Guedras strongly criticizes the methods of operation of electric furnaces as advanced by Lemoine (Etude et conduite des operations au four electrique basique. R. Lemoine. *Aciers Spéciaux, Métaux et Alliages*, Vol. 9, July 1934, page 198). Based on 25 years of experience, Guedras illustrates with concrete examples the reasons for his criticism. Whereas Lemoine would not let C drop below 0.10%, Guedras has made steel with 0.006% and the slag was well deoxidized. Guedras was successful in carburizing a heat from 0.50% C to 3.9% C by adding charcoal or anthracite coal to the bath after the slag off. Guedras does not recommend Lemoine methods of making electric steel. GTM (3b)

Finishing the Heat of Steel. Pt. XXXIII—XXXIV. J. H. HRUSKA. *Blast Furnace & Steel Plant*, Vol. 23, July 1935, pages 469-470; Aug. 1935, pages 536-537. Discusses dimensions and taper of ingots. MS (3b)

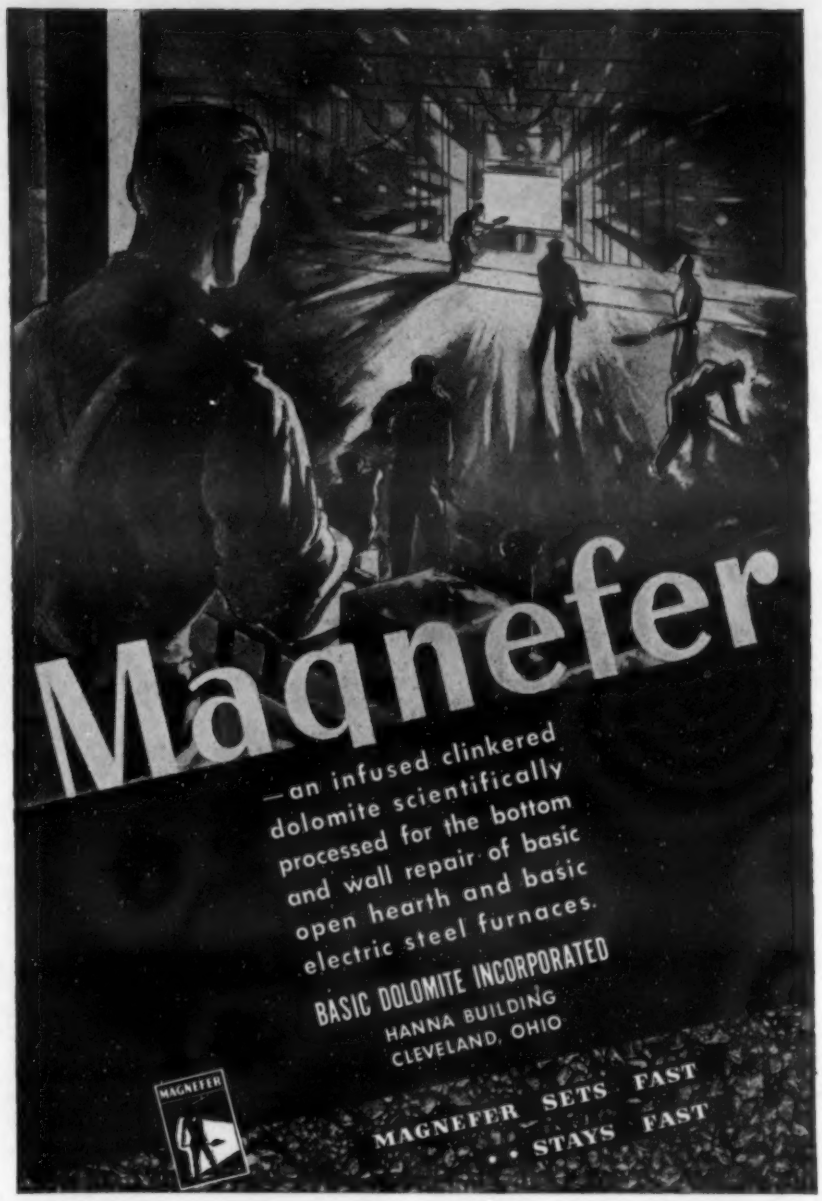
Copper Additions to Grey Cast Iron. J. HIRD. *Foundry Trade Journal*, Vol. 52, May 9, 1935, pages 318, 322. Paper contributed to Birmingham, Coventry and West Midlands Branch of Institute of British Foundrymen. Author studied effect of a Cu addition to cast Fe. The Fe in general use had the following analysis: Total C=3.2; Si=2.75; P=1.0; and a Cu addition of 2.5 was made to this Fe. The unalloyed Fe showed a fine pearlitic matrix with considerable amounts of ferrite. In the alloyed Fe, the ferrite was present in much smaller quantities. Brinell hardness test showed:

Brinell hardness 207 for Fe without Cu.
Brinell hardness 235 for Fe with Cu.

From the experiments carried out by the author it appears that small additions of Cu to a common gray Fe give harder and closer metal, at the same time reducing the tendency to chill. It is pointed out by the author that the whole of the Cu went into solution, although, according to some published literature, the solubility of Cu in cast Fe is lower than the amounts used in these experiments. AIK (3b)

Regulation of Cupola Furnaces (Réglage de Cubilots). G. HÉNON. *Bulletin de l'Association Technique de Fonderie*, Vol. 9, Feb. 1935, pages 42-56. Paper presented at Dec. 1934 meeting of the A.T.F. See *Metals & Alloys*, Vol. 6, June 1935, page MA 223L/4. WHS (3b)

Modern Cast Iron. R. G. MCELWEE. *Mechanical Engineering*, Vol. 57, July, 1935, pages 429-430. Modern foundry technique is discussed in the light of producing cast Fe of definite properties and melting practice. It is suggested that definite specifications and even exact prescriptions as to composition be given to the founder by the customer or engineer. Ha (3b)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Alloy Cast Irons. A. T. WEARE. *Foundry Trade Journal*, Vol. 52, May 9, 1935, page 318. Paper contributed to Birmingham, Coventry and West Midlands Branch of Institute of British Foundrymen. Effect of Ni, Cr, Mo and austenitic cast Fe are discussed. It has been shown that small additions are of importance in assisting production by improving strength, density, pressure tightness and machinability. The austenitic Fe is of special interest where castings possessing high expansion are required to work in conjunction with Al alloys. AIK (3b)

Founding High Test Cast Iron. W. R. JENNINGS. *Foundry*, Vol. 63, June 1935, pages 28-29, 66, 68. Abstract of paper presented at East Lansing sectional meeting of the American Foundrymen's Association, Michigan State College and Detroit Foundrymen's Association. In high test cast Fe which will meet desired specifications it is necessary to have consistency in practice. Practical aspects of founding Fe of 30,000 lbs./in.^{2} tensile strength and over are given. Typical material specification for high test Fe to cover an Fe in a severe application: (1) Microstructure desired has a fine pearlite as matrix. Graphite C shall be small and evenly distributed in fine flakes. Free ferrite, steadite or cementite not desired. (2) Physical properties shall be: tensile strength 48,000 lbs./in.^{2} minimum; Brinell hardness 223-248; Transverse strength 5,000 lbs. minimum on 1.20" diam. bar, tested on 12 in. centers; and Resilience must be 425 in. lbs. minimum. (3) Chemical analysis shall be: Total C 2.90-3.10; combined C 0.60-0.80; Graphite C 2.50 maximum Mn 0.50-0.80; P 0.20; S 0.09; and Mo 0.35. (4) Castings must be free from blowholes, shrinks, casting strains, etc. (5) Chemical analysis may be modified to obtain microstructure and physical properties specified. VSP (3b)

Making High Impact Strength Cast Iron in an Electric Furnace (Fabrication au four électrique de la fonte à résistance élevée au choc). ALBERT KAYL. *Journal du Four Electrique*, Vol. 44, June 1935, pages 211-212. Difficulties of producing tough cast Fe in a cupola can be remedied by using a duplex process, cupola-electric furnace. Operating methods are briefly described both for all iron heats and for electric furnace scrap heats. The latter can be advantageous only when current is cheap. JDG (3b)

A Review of Factors Influencing the Soundness and Solidity of Grey Iron Castings. J. L. FRANCIS. *Foundry Trade Journal*, Vol. 52, May 2, 1935, pages 295-297. Large proportions of badly rusted, burnt or otherwise oxidized scrap in the charge will greatly tend towards a gassy melt. The casting, shortly after pouring, consists of (1) the austenitic crystals, (2) liquid of similar composition, (3) Solid graphite and (4) the liquid phosphorus eutectic. The author emphasizes that castings designed to withstand pressure should be poured with metal having a temperature of not less than 1350° C. When deciding on where castings should be run, it is well to bear in mind that the perfectly cooled casting would be the one in which all the metal solidified at all places simultaneously. Irons of eutectic composition have all characteristics needed for making definitely sound castings. In the author's experience, it has been found that for high-class work the total C content should not drop below 3% and for cylinder work, having variation in section, an increased amount of total C up to 3.5% is desirable. The present day tendency for the total C contents below 3% leads to difficulties. Retention of inherent properties, chemical composition, effect of alloys, etc., are discussed. AIK (3b)

Investigations into the Metallurgical Progress of the Basic Open-Hearth Process (Untersuchungen über den metallurgischen Verlauf des basischen Siemens-Martin-Verfahrens). P. BARDENHEUER & G. THANHEISER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 17, No. 10, 1935, pages 133-147. The metallurgical course of the basic open hearth process was studied experimentally by 8 melts observing the changes of concentration of bath and slag, taking into consideration especially the O content, the reaction of which with C is of prime importance in the process. This reaction takes place very rapidly with high C contents and at higher temperatures. As long as more than 0.2% C is present in the steel melt and no deoxidizers added the C alone determines the O content of the bath. The more C drops below this limit the more the O content of the bath is determined by the ferrous oxide content of the slag. In order, therefore, to produce a low C steel a low ferrous oxide final slag is necessary. If the concentration of O in the steel or FeO in the slag is too low, or if the temperature and viscosity of the slag are too low or high respectively, the reaction of O with C is retarded. The bath should boil long and strongly enough to rid the steel of gases. Mn content of bath and manganous oxide content of the slag control the ferrous oxide content of the slag and therefore the O supply to the bath and boiling velocity. High Mn content prevents the O content becoming too high in low C steel melts. Introduction of ferromanganese or other ferroalloys into the steel bath for deoxidation purposes incurs the danger that gases get into the bath at a time when they can no longer be removed from it by boiling; also the total content of oxides in the steel may be rather increased by the introduction than reduced. Manganous oxide in the finished steel can rise only slowly into the slag and in pouring attacks the SiO_2 rich materials of the ladle lining, spout and causes injurious silicate inclusions. 14 references. Ha (3b)

Slag Systems; Existence of Grünerite. R. HAY, JAMES WHITE & A. B. MCINTOSH. *Iron & Coal Trades Review*, Vol. 131, Aug. 9, 1935, pages 200-201. Previous work on the system FeO-SiO_2 revealed a discrepancy between thermal and optical evidence on the existence of grünerite which it was endeavored to clear up by making new melts containing 50% and more of silica, FeO and MnO. In all cases, silica was found to exist as a free phase, and was partially transformed to cristobalite so that the non-existence of grünerite was established and previous work of Herty and others confirmed. A light brown substance with a refractive index of 1.74 which was found turned out to be a eutectic material made up of fayalite and silica in intimate association. A study of the ternary system FeO-MnO-SiO_2 shows that FeO may only be present as (1) FeO phase, (2) fayalite, and (3) knebelite phase; the latter dissociates to a large extent so that all the FeO is available as oxidizer because of the presence of MnO which forms a stable silicate with the liberated SiO_2. Free FeO seems to be the most active oxidizer. Ha (3b)

The Elimination of Physical Defects in Deep Drawing Steels. T. G. GREY-DAVIES. *Sheet Metal Industries*, Vol. 9, Aug. 1935, pages 487-488. Cu, Ni and Sn are pointed out as contaminants with which the steelmaker must contend. Cu and Ni up to 0.4% seem to have little effect on the sheet bar or final product, but over 0.10% Sn interferes during hot rolling. Non-metallic inclusions are discussed. AWM (3b)

The Shell-shaped Removal of Loam Cores (Die schalenförmige Entfernung von Lehmkernen). E. FEIL. *Giesserei*, Vol. 22, Aug. 16, 1935, pages 401-406. Experiments were made to find best conditions for and composition of cores when casting hollow parts, tubes, etc. to remove the core as smoothly and in as large pieces as possible to save time. Loam for the core and the dressing (blackwash) has proved the best material as it possesses sufficient strength after the cast is finished and dressing and core adhere well together. The latter does not stick to the casting and gives a smooth surface. A certain amount of C in the mass is advantageous for the removal of the core from the casting. The technique of making the core and selecting the constituents is described in full. Ha (3b)

New Viewpoint on the Origin of Flakes in Steel. HANS DIERGARTEN. *Metal Progress*, Vol. 28, July 1935, pages 51-52. Discussion of various theories as to cause of "flakes" or internal ruptures in steel billets and forgings with special reference to recent work of Houdremont and Korschan offering the presence of H_2 as the cause. Repeated forging is found to decrease tendency to flake when properly cooled and over-oxidation fails to cause flakes when steel is properly cooled. These workers find that acid melted steel, (crucible, open-hearth or high frequency) is less sensitive to flakes than basic steel (open-hearth or electric); lower pouring temperature somewhat reduces tendency but slower pouring rate is more effective in reducing the tendency to flake; large ingots tend to flake more readily but ingot character is without effect except that uncoated or graphite coated molds tend to produce insensitive ingots. Flakes are said to form in region of 400° F. WLC (3b)

Use of Cast Iron Scrap in Cupola Expedited by Addition of High Silicon Iron. A. H. DIERKER & R. P. SCHNEIDER. *Iron Age*, Vol. 135, May 16, 1935, pages 23-25. From Ohio State University Engineering Experiment Station Bulletin No. 88, 1935. The recent practice of replacing with steel scrap an equivalent amount of pig Fe in the charge of a cupola furnace normally consisting mainly of cast Fe scrap was studied with regard to its effect on the quality of the cast Fe. It was found that it is quite possible to produce a quality cast Fe with only small percentages of pig Fe in the charge provided proper control of Si and Mn is exerted. It depends to a certain extent also on whether an iron of high strength or good machinability is desired. This can be controlled by the Si content. The use of 2 grades of blast furnace ferrosilicon, one low and one high in Mn, seems to be both convenient and effective in producing the correct composition of Si and C. Ha + VSP (3b)

Brief Review of Steel Melting Processes and Their Effect Upon the Quality of Steel (Kort overzicht der staalsmeltprocessen en hun invloed op de kwaliteit). W. BECKERS. *Polytechnisch Weekblad*, Vol. 29, Mar. 7, 1935, pages 145-149; Apr. 16, 1935, pages 248-250. The chemical reactions underlying the main steel melting processes are discussed and 4 diagrams are presented showing the elimination of C, P, Mn, S and Si in relation to melting time of acid and basic open hearth, Thomas and Bessemer processes. Average chemical analyses of the slags used in these 4 metallurgical processes are given. Typical furnace constructions are shown. WH (3b)

Important Data for the Production of Chill-Castings with Particular Consideration of Chill-Cast Rolls (Wichtige Daten für die Hartgusserzeugung unter besonderer Berücksichtigung des Hartwalzengusses). H. BOCEK. *Giesserei*, Vol. 22, July 19, 1935, pages 357-364. The chemical properties, metallographic structure of the charge, melting furnaces and temperatures to be applied, and the influences which determine the properties of chill-cast rolls are discussed. In general, it can be stated that for the production of chill castings, the charge should not be made up of irons which differ too much in Si content, that is, types of Fe some of which harden and some which do not harden, as no uniform structure and no uniform hard shell can be produced in this manner, and casting stresses occur which reduce strength quite considerably, increase brittleness and favor formation of cracks. The great influence of Si in this respect is shown in micrographs of structures and failures. Ha (3b)

The Electric Arc Furnace in Steelworks and Foundry (Le four électrique à arc en aciérie et en fonderie). R. BOUTIGNY. *Journal du Four Electrique*, Vol. 44, Apr. 1935, pages 136-141; May 1935, pages 175-178. See *Metals & Alloys*, Vol. 6, Aug. 1935, page MA 318L/9. JDG (3b)

Rotor Castings of Ferrous Metals. A. E. BRUCHANOFF. *Metallurg*, No. 3, 1934, pages 49-51. In Russian. Mold with a liquid steel is placed within the stator of a 3 phase A.C. motor. The magnetic field of the stator is sustained by an electric current during the whole period of solidification. The liquid steel during the solidification is rotated and as a result the following advantages of ingot structure are obtained: (1) uniformity of composition, (2) uniform distribution of inclusions, (3) smaller grain size, (4) less segregation and pipe. The composition of one investigated steel is: 0.6% C; 3% Ni; another: 2% C; 25% Ni. VK (3b)

Insulation and Control of Open-hearth Furnaces. WILLIAM C. BUELL, JR. *Metals Technology*, Aug. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 641, 15 pages. The various kinds of insulating materials available for use on open-hearth furnaces are described. Heat flow is discussed and solutions of heat-flow problems are given. Control of furnaces is considered from a broad point of view. It is concluded that improvement in furnace operation will come rapidly when the truth is driven home that before refinements to operation can be even partly successful the fundamental design of the furnace and its system must be developed until no further basic improvements can be made. JLG (3b)

A Modern Foundry. *Engineer*, Vol. 160, July 12, 1935, pages 44-45; *Engineering*, Vol. 140, July 12, 1935, pages 35-38. Illustrated article describing the plant of Winget's Ltd., at Rochester, Kent, England. This has been constructed during the past year. A plan of the plant lay-out is given. "Meehanite," a cast iron with a calcium silicide admixture is made here. The method used is such that the degree of surface chilling can be predicted so accurately that cam shafts are cast with the necessary degree of hardness without further heat treatment. LFM (3b)

High-Speed Steels Produced in Induction and Arc Electric Furnaces. *Metal Treatment*, Vol. 1, Summer 1935, pages 103-105. A correlated abstract. JCC (3b)

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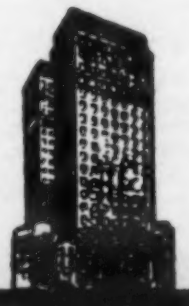

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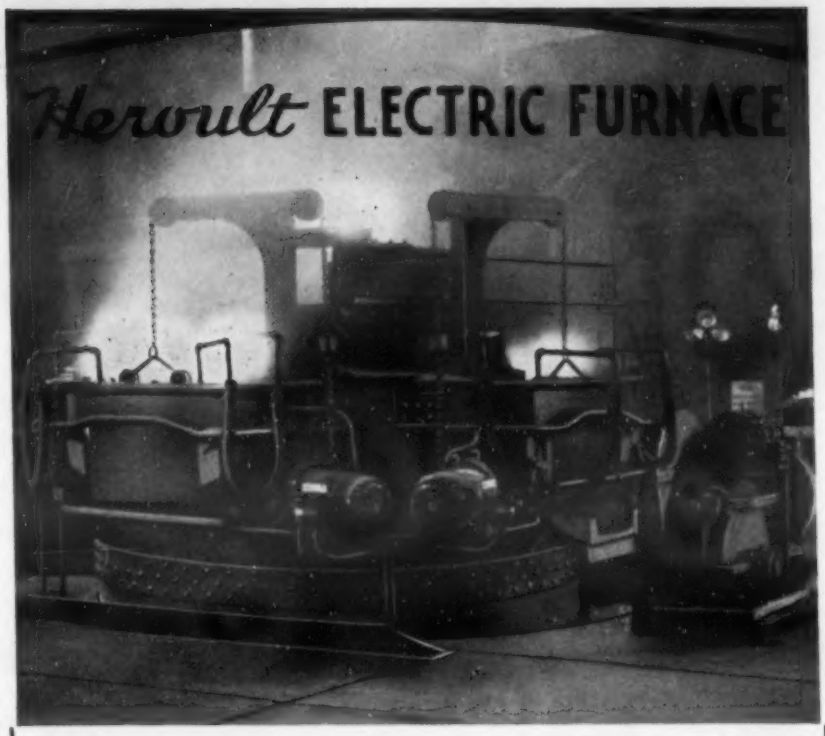

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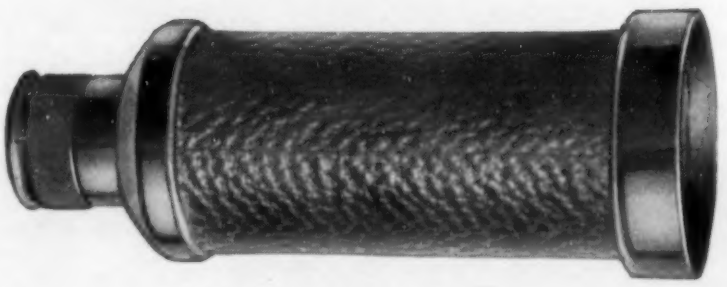

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4. WORKING

Note on the Treatment of Light Alloys in U.S.S.R. The Forging, Stamping and Heat Treatment of Elektron (Note sur la technique des alliages légers en U.S.S.R. Le forgeage, l'estampage, et le traitement thermique de l'elektron.). MICHEL PRÉCOUL. *Chaleur et Industrie*, Vol. 16, May 1935, pages 241-243. Elektron is used for aeroplane propeller blades in U.S.S.R. Hot working must be carried out between 330° and 380° C., necessitating frequent reheatings. Heat treatment at 350° C. for 8 hours is recommended to produce a uniform product with high elongation. The following average test results are recorded:

	Ultimate Strength	Elongation	Brinell Hardness
Cast	18.0 Kg/mm.²	18%	52
Rolled	23.0	11	57
Forged—longitudinal ...	26.6	11.2	59.6
Forged—transverse	20.4	12	56.8
Heat treated 24-25		9-15	—

JCC (4)

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Welding of Blow Holes in Rimmed Steel Ingots. ISAMU KOHIRA. *Tetsu-to-Hagane*, Vol. 21, Mar. 25, 1935, pages 165-187. One distinctive feature of the rimmed steel ingot is the location of internal gas holes, and very little is known of their properties after mechanical hot working. By the present investigation it was confirmed that they may be welded by either forging or hot rolling. In the first experiment a number of specimens cut off from the ingot were forged to various thicknesses in a certain direction. In the second experiment many ingots were rolled to various sections of blooms, and the relations of degree of welding and the macro- or microstructure and the mechanical strength were studied. The results obtained from hot rolling showed that for the complete welding of blow holes in mild or semi-mild steel ingots, reduction of ingots must be 90-96% TS (4a)

Production of Cold Rolled Auto-Sheets. F. L. PANASENKO. *Domez*, No. 2. 1935, pages 25-40. In Russian. Specifications used in Russia for cold rolled auto sheets are given. They are practically the same as those of DIN. The 3 cold rolling plants now operating in Russia are briefly described. They use either 3-high or 4-high mills. Mechanism of the operation of cold rolling mills is analysed. Cold rolling with oil lubrication does not change the physical properties of the sheets produced but greatly increases the efficiency of the operation. A series of experiments showed that a reduction from 2.2 mm. to 1.18 mm. required 11 passes without lubrication and 7 passes when the sheets were oiled. In the last 4 passes in the first case the distance between the rolls was 0.05 mm., in the second case 0.10 mm. The play of the rolls is greater when the sheets are not lubricated. 7 passes on lubricated sheets produced 70% reduction, on the dry sheets 60%. (4a)

Manipulators for Rolling Mills (Apareils culbuteurs pour laminoirs). L. DE FEYDEAU. *Géne Civil*, Vol. 106, Feb. 23, 1935, pages 182-184. Drawings and brief description are given of 13 types of manipulators used all over the world. JDG (4a)

Hot Strip Steel Rolled On Steckel-Type Mill. *Iron Age*, Vol. 135, June 27, 1935, pages 12-17, 78. Hot strip steel is being rolled on a commercial basis on single-stand reversing mill of Steckel type. This type of mill has an output of from 25 to 35% of that of a continuous strip mill and initial cost of about 1/6th of continuous type. This enables small steel companies to produce their own hot strip steel. Describes the manufacture of strip steel by this process and enumerates advantages claimed. Gives a detailed account of a new mill capable of rolling strip 16" wide installed by the McLouth Steel Corpn., Detroit. VSP (4a)

New Hot Strip Mill at Youngstown Sheet & Tube Co. Goes into Operation. *Iron & Steel Engineer*, Vol. 12, May 1935, pages 288-289. Descriptive. WLC (4a)

The Variation of Substance in Tinplate. J. SELWYN CASWELL. *Proceedings South Wales Institute of Engineers*, Vol. 50, Feb. 12, 1935, pages 339-403. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. AHE (4a)

Influence of Roll Neck Deflection on Life of Anti-friction Bearings. A. H. FRAUENTHAL. *Iron & Steel Engineer*, Vol. 12, June 1935, pages 356-360; *Iron Age*, Vol. 135, May 2, 1935, pages 30-33, 108; *Steel*, Vol. 96, Apr. 29, 1935, pages 50-53. **Maintenance of Roll Neck Bearings.** *Blast Furnace & Steel Plant*, Vol. 23, May 1935, pages 329-330, 340-341. Failure of bearings often due to poor load distribution. Many top roll mountings are favorable because of flexibility. No past method of bottom roll mounting permits self-alignment due to friction. Roller aligner accomplishes self-alignment and good distribution by its anti-friction character. WLC+MS+VSP (4a)

Automatic Sheet Measuring Device. GORDON W. FIRST. *Iron & Steel Engineer*, Vol. 12, May 1935, pages 292-293. Measures length of sheet as it passes through the mill. Fixed pointer on dial is set in position indicating desired length and moving pointer moves with the sheet as soon as it reaches flag switch on catcher's table until back end of sheet passes over switch. Registration of moving pointer remains on dial until returned to zero position. Flag switch may be photoelectric cell operated or by some suitable mechanical means. WLC (4a)

Automatic Screwdown Control. R. M. BAYLE. *Iron & Steel Engineer*, Vol. 12, July 1935, pages 425-429. Descriptive of automatic screwdown on rolling mill equipment. WLC (4a)

Roll Neck Bearings. G. PALMGREN. *Iron & Steel Engineer*, Vol. 12, June 1935, pages 347-354; *Steel*, Vol. 96, Apr. 29, 1935, pages 49-50. Describes development, design and advantages of spherical, double row, self-aligning bearings for roll necks. WLC+MS (4a)

Maintenance of Roll Neck Bearings. H. D. ROBB. *Iron & Steel Engineer*, Vol. 12, June 1935, pages 342-345; *Steel*, Vol. 96, Apr. 29, 1935, page 49. Discusses proper lubrication, frequent inspection of condition and record of service. WLC+MS (4a)

Precision Mills for Rolling Strip, Bars and Rods. S. M. WECKSTEIN. *Preprint American Iron & Steel Institute*, May 1935, 16 pages; *Iron Age*, Vol. 135, May 23, 1935, pages 22-25B; *Blast Furnace & Steel Plant*, Vol. 23, June 1935, pages 390-394, 398. **Roller Bearings Important in Precision Rolling Mills.** *Steel*, Vol. 97, July 1, 1935, pages 34-35. A review with diagrams of mills for rolling strip, bars and rods. Roller bearings have been responsible for the attainment of extreme accuracy in continuous and other mills. VVK+VSP+MS (4a)

New Installation for Making Seamless Tubes by Drawing Bench Method (Nouvelle installation pour la fabrication de tubes sans soudure, par le procédé du banc poussant). JEAN MARETTE. *Revue de Métallurgie*, Vol. 32, June 1935, pages 233-244. Mechanical features of the first French installation making seamless tubes according to Wellman method. Plant is designed to average 100-120 tubes/hours, 7.5 m. long and 10 cm. outside diameter. Diagrams of power consumption at different stages of the process are given. JDG (4a)

Electric Controllers for Three-High Sheet Roughing Mill Screwdowns. J. J. MELLON. **Screwdown Control.** F. J. BURD. **Automatic Preset Screwdown Control.** W. M. BALLENGER. *Iron & Steel Engineer*, Vol. 12, July 1935, pages 430-436. Further discussion of the application of automatic control to the problem of screwdown on rolling mills. Various designs and methods described. WLC (4a)

Effect of Roll Diameter in Cold Rolling of Strip Steel (Der Einfluss des Walzendurchmessers beim Kaltwalzen von Bandstahl). W. LUEG & ANTON POMP. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 17, No. 5, 1935, pages 63-76. Experiments with 3 C steels and 1 Si steel showed that the rolling pressure increases with increasing reduction of the pass at first rapidly and then almost linearly, and increases proportional to the roll diameter for constant pass reduction. The pressure increases with increasing C content; the deformation efficiency, however, becomes worse. Ha (4a)

Field Drawing of Roll Neck Bearings. S. F. KEENER. *Iron & Steel Engineer*, Vol. 12, June 1935, pages 345-346. Describes immersion heater type of oil drawing bath as a low first cost furnace for drawing roll neck bearings with uniform temperature conditions. Treatment should be given every 3-6 months. WLC (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

The Forgeability of Welded Joints (Ueber die Schmiedbarkeit von Schweissverbindungen). HEINZ BECKER. *Autogene Metallarbeitung*, Vol. 28, July 1, 1935, pages 193-202. The effect of forging on welds made by different processes was investigated on a structural steel. The tensile strength of electric, autogenous and arcatom welds with unalloyed bare welding rods is not improved by forging; notch-toughness of electric welds with bare welding rods is deteriorated on account of the high O and N content of the weld, but that of autogenous and arcatom welds is improved by forging at 1050°-950° C. because of the fine grain produced by forging; also the fatigue bending strength is improved. When using welding rods with higher C and Mn contents, the mechanical properties are improved in almost all cases by forging at 1050°-950° C. A method is elaborated which permits defining numerically the forgeability of a welded joint. The greatest degree of forgeability is attained in welds made with rods with higher C and Mn content when a strong deoxidation of the weld can take place. Arcatom welding gives the best, autogenous welding a medium, and electric bare wire welding the lowest degree of forgeability. Ha (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

New Methods of Working Locomotive Rod Bearings (Neuartige Lokomotivstangenlagerbearbeitung). K. MARTIN. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 90, Jan. 15, 1935, pages 23-27. In the Reichsbahn repair shop at Brandenburg-West the locomotive rods are straightened out on a special machine. In the same set-up, a 1 mm. babbitt lining is cast under a pressure of 15 atm. into the shells. The bearing alloy exhibits a fine grain and tenaciously adheres without an intermediary layer of Sn. The bearing surface of the babbitt is not finished by machining as heretofore but by rolling (few tenths of 1 mm.) The rolling induces the necessary strength and provides for an as-polished surface. Whereas the former method consisted of 17 different working operations, the new one involves only 8, and shows savings of 90% of babbitt, while the working time is reduced considerably and fit, wear resistance and safety of the bearing are improved. The service time is doubled. Micro-structures of a babbitt ingot and the same alloy cast at high pressures and subsequently rolled, prove that the hard bearing constituent is distributed much more evenly by the new process. The bearing surface is thus enlarged and wear reduced. The densifying effect due to rolling is also shown in micro-photographs. WH (4c)

Rolling-in Boiler Tubes (Das Einwalzen von Kesselrohren). Eh. Höhne. *Elektrizitätswirtschaft*, Vol. 33, Nov. 5, 1934, pages 454-458. Discusses nature of rolled tube joint, principal influences during rolling such as tube and plate material, tube wall size and plate thickness, surface conditions, widening-up speed, clearance, grooves, flanging, heating of rolled joints. Characteristic features of the most important rolls employed, further means of attaching tube to boiler, correct and faulty rolling-in are taken up. The experimental results are mainly based on investigations of Jantscha, Ruttmann, and Siebel. Harder tube and plate steels yielded a better rolled joint than softer grades. With the latter a larger degree of expanding is possible whereby use is made of their strain hardening ability. If harder alloy tubes are utilized, alloy plate material should also be used. After finishing the joint, the yield point of the plate material should be higher than that of the tube material. WH (4c)

Wire-Drawing of Copper (Le Tréfilage du Cuivre). G. de Lattre. *La Technique Moderne*, Vol. 27, June 15, 1935, pages 402-406. Studies changes of mechanical properties of Cu as a function of deformation. Cu used contained about 0.04% O. Tensile strength and elastic limit increase steadily for a reduction up to 16.7% whereas elongation decreases from 43 to 6%. Over 16.7% reduction, properties vary little. In practice, a rough pass of 20% reduction is given to the wires and the total reduction for all kinds of wires is about 35-40%. Second section discusses factors affecting wire-drawing: (1) angle of die stock opening: resistance to flowing decreases as angle increases up to 12°. When the angle is greater than 16° the resistance to flowing remains practically constant. (2) Reduction of section: stress required for drawing is proportional to reduction of section. The greater the reduction of section the more uniformly distributed the deformation. (3) Shape of flow opening: conical opening gives good results and is easy to produce. (4) Drawing speed: results are different with steel and W carbide die-stocks. In the case of steel, as speed increases necessary drawing stress increases first slowly, then remains constant and at last decreases. In the case of W carbide, drawing stress increases up to a maximum then decreases to remain at a constant value. The latter is now preferred to the former because they have a good lubricating power but they ought to be thoroughly cooled. (5) External rubbing coefficient: finish of die determines finish of wire surface and power required. Till recent times lubricant used was soap solution but now special dry soaps are preferred. Last section describes apparatus used in modern wire drawing plant. FR (4c)

Aluminium Spinning. R. H. Ure. *Sheet Metal Industries*, Vol. 9, Feb. 1935, page 100. Points out the advantage spinning holds over presswork for small-lot work. AWM (4c)

Recent Developments in the Use of Presses and Press Tools. N. C. Wilson. *Journal Institution of Production Engineers*, Vol. 14, Apr. 1935, pages 179-203. With discussion. Includes data for calculating the pressures required for blanking, bending, drawing, embossing, and hot-pressing various materials. JCC (4c)

Influence of the Form of the Die Orifice on the Internal Stresses and Tensile Properties of Cold Drawn Rods (Einfluss der Düsenform auf Eigenspannungen und Festigkeitseigenschaften altgezogener Stahlstangen). H. Bühler. *Archiv für das Eisenhüttenwesen*, Vol. 8, Apr. 1935, pages 465-466; *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke Aktiengesellschaft Dortmund*, Vol. 4, Dec. 1934, pages 197-206. Cylindrical die orifices gave relatively high internal stresses. Sharply concave orifices caused most deformation at the surface, so that smaller internal stresses appeared. The usual shaped die orifices required the least power, next came the sharply concave, and the cylindrical orifices required the most power. The usual dies gave good surface, but for exceptionally smooth surface a sharply concave die may be recommended. Such orifices increased the tensile properties of the rod; there was no marked effect on the elongation and reduction of area. SE + Ha (4c)

Rope Wire Cups, Bad Torsion and Fatigue. R. Saxton. *Wire & Wire Products*, Vol. 10, July 1935, pages 265-266, 290-291, 294. Proper heat treatment and proper mechanical conditions are discussed which must be maintained to draw high tensile material free from defects as formation of cups and inner stresses and of a high quality. Ha (4c)

Cold-Working and Handling of Light Metals (Kaltverformung und Behandlung der Leichtmetalle). W. Wegener. *Metallwaren-Industrie & Galvano-Technik, Section Werkstoffkunde & Verarbeitungstechnik*, Vol. 33, Mar. 15, 1935, page 125. Remarks on bending and deep-drawing of light metal alloys. German trade names but no analyses are given. EF (4c)

4d. Machining

H. W. GRAHAM, SECTION EDITOR

Metal Cutting. Hans Ernst & M. Martelotti. *Mechanical Engineering*, Vol. 57, Aug. 1935, pages 487-498. The mechanism of chip-forming metal cutting was studied, the high stresses and consequent large deformations on the material occurring in the cutting process were examined by microphotographs. The magnitude of the built-up edge can be decreased by decreasing the chip thickness, by an increase in rake angle and tool sharpness, by application of lubricant to the tool face and an increase of cutting speed. Ha (4d)

A Bibliography on the Cutting of Metals. Part II. Orlan W. Boston. Edwards Brothers, Inc., Ann Arbor, Mich., 1935. Cloth 5½ x 8 inches, 202 pages. Price $2.50.

A bibliography on this subject, compiled by the author, was published in 1930 as a research publication of the American Society of Mechanical Engineers. It contained some 700 references with short abstracts. Since the publication of that bibliography, additional references have accumulated. These are now compiled into a bibliography of 1257 additional references. The references are arranged chronologically by author. They are indexed by author and subject similar to the first bibliography. The subject matter is lithoprinted. Richard Rimbach (4d)-B-

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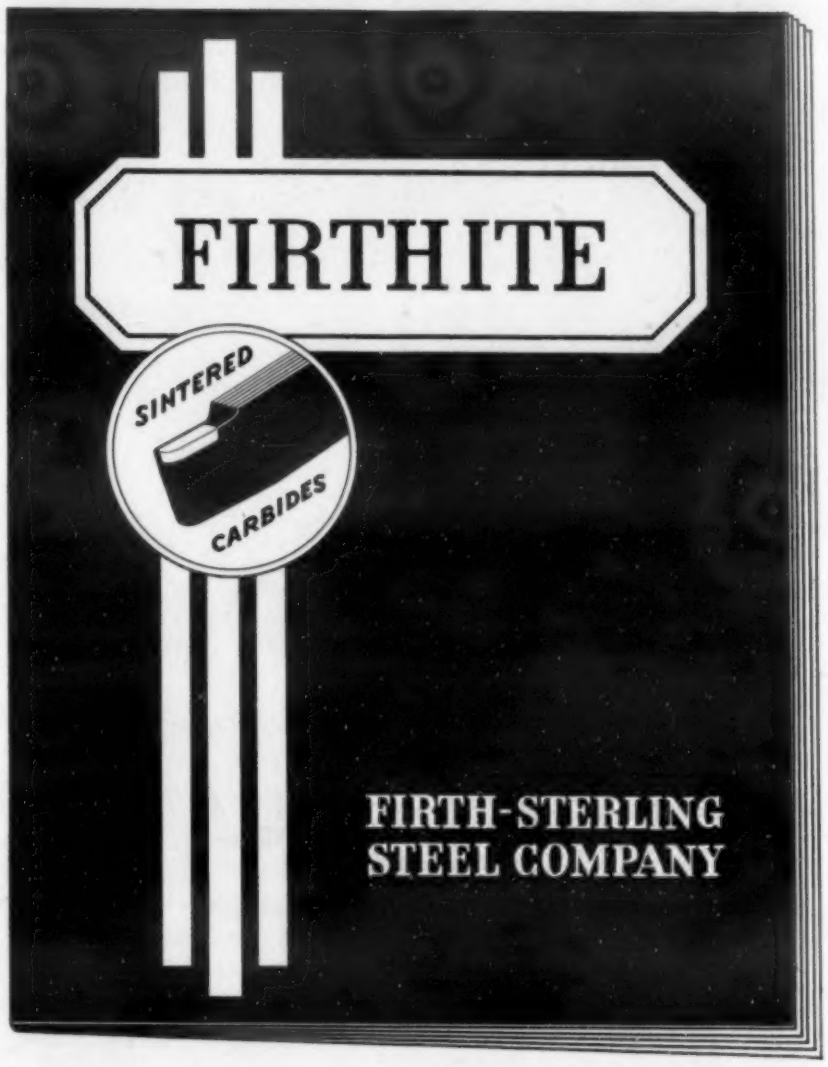

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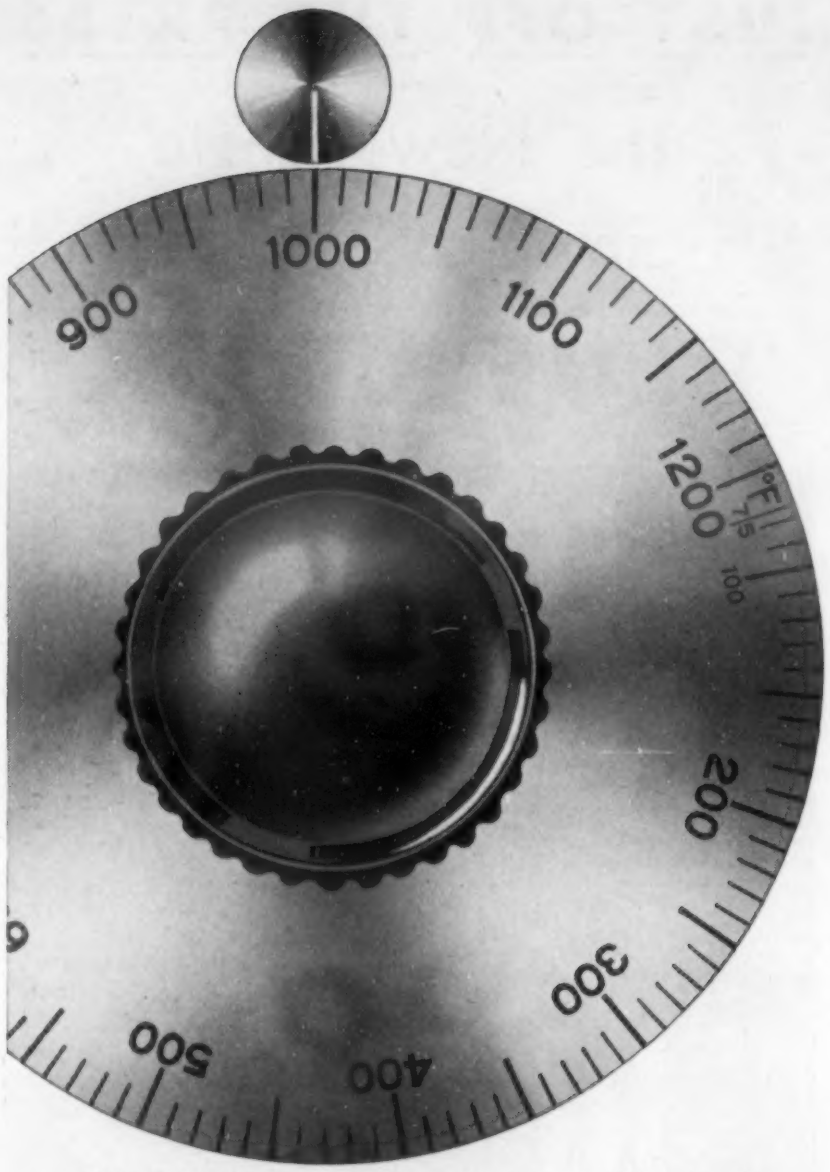

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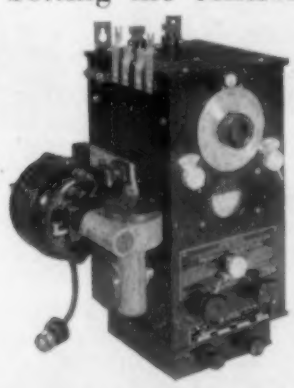

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5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

Practical Metallurgy. Part III. Heat Treatment (Praktische Metallkunde. Dritter Teil. Wärmebehandlung). GEORG SACHS. Julius Springer, Verlag, Berlin, 1935. Cloth, 6¾ x 9¾ inches, 203 pages. Price 17 RM.

The preceding two volumes of this book dealt with melting and casting and with forming, respectively. The present volume is a dissertation on heat-treatment, both for the transformation type of process occurring in steel and for the precipitation type of process occurring in duralumin. It is divided into three sections: the first (95 pages) is on the general laws governing changes in state, including discussions of the significance of constitutional diagrams, of structural changes, of precipitation processes, and of transformation processes; the second section (85 pages) is an outline of the constitution and behavior of alloys responding to heat-treatment, and is divided into sections on light alloys, copper alloys, noble metal alloys, nickel and cobalt alloys, iron and steel, and low-melting alloys; the third section (16 pages) is a treatment of magnetic properties (by A. Kussmann) chiefly from the standpoint of the effect of heat-treatment.

Something of the distribution of subject matter may be inferred from this. It should be stated that age-hardening in non-ferrous alloys is discussed far more completely than the heat-treatment of steel, which is covered in a rather cursory fashion. The reader may well be disappointed in this feature of the book. We find, for instance, only a scant mention of Bain's brilliant work, and we find no reproduction of his now well-known diagram of the "S-curve" representing isothermal reaction rates at different temperature levels with superimposed cooling curves, which has simplified this complicated subject in the mind of everyone. The need for a really modern book on the subject of the heat-treatment of steel, written fully and with the feeling for organization of material which is so marked in the present book, is very great. Books now available on this subject in English are of little use to the scientific metallurgist, and for that matter to the practicing metallurgist also, owing to the great volume of really fundamental work which has been done in the last ten years, and especially in the last five years.

It should be stated immediately, however, that with the distribution of subject matter adopted by the author—and the choice of subject matter is an inalienable right of any author—the book is a remarkably fine one. It may well startle the average reader to note the type of material included in this book on "practical metallurgy," for, to resort to an Americanism, when an American metallurgist says practical, he means *practical!* It has been the purpose of the author to present the subject of heat-treatment in an orderly fashion, with each bit of information properly placed in a systematic outline. He proceeds, therefore, from a discussion of the types of alloys susceptible to heat-treatment, to a discussion of the nature of the processes which obtain during heat-treatment and subsequently as a result of heat-treatment, and ultimately to a discussion of the important heat-treating alloys, insisting all the while, at least by implication, on the importance of an *understanding* of the processes involved.

As a result of this point of view we find surprisingly thorough discussions of such subjects as the crystallographic mechanisms of transformation and precipitation, alterations in lattice parameter during aging (accompanied by reproduction of photograms), and transition structures, to select a few. These discussions, not too long in extent, lead to more mundane subjects, so that the "practical" point of view is adequately represented—see, for instance, the discussions of the corrosion of age-hardening alloys, the effect of third elements on age-hardening, heat treatment technique, and many others. It is evident that the author has attempted to maintain a balance between theory and practice in a subject which is developing so rapidly that a lively interplay between theory and practice is proving most fruitful in the developing of new alloys and new heat-treatments.

The reviewer must confess that this mode of treatment appeals to him strongly. It is no longer necessary for the chemical engineer to apologize for the discussion of such erudite subjects as rates of evaporation and the mathematics of heat-transfer, nor in any way to feel expatriate from his profession if he does so. We must see that metallurgy is following a similar line of development: it may well be that the practical heat-treater will shortly think it as important to understand transition lattices and the kinetics of the decomposition of austenite as the chemical engineer now believes it necessary to understand and to use the kinetic theory of gases and reaction velocity equations. In this respect the present volume (as indeed much of Sach's work) may well be an active harbinger of the future. It is by all odds the most complete account of the science of heat-treatment now available, serving at once as an advanced text, and, because of the thousands of references, as a source book. In no other place will as complete an account of various phenomena of age-hardening be found as in this book. Robert F. Mehl (5)-B-

Age-Hardening Cast Aluminium Alloys. E. SÖHNCHEN. *Metal Treatment,* Vol. 1, Summer 1935, pages 70-75, 81. Translation of article in *Die Giesserei,* March 1935. See "Heat-treatment of Hardenable Aluminum Cast Alloys," *Metals & Alloys,* Vol. 6, June 1935, page MA 226R/2. JCC (5)

5a. Annealing

Change of Banded Structure in a Hot Rolled Steel by Various Heat Treatments. YASUFUMI DOI. *Suiyokwai-Shi,* Vol. 8, Aug. 1935, pages 769-774. In Japanese. A hot rolled low C steel having banded structure was treated in N atmosphere and the influence of heating temperature, heating time, cooling rate and repeated heating upon the elimination of the structure in question was investigated. The higher the heating temperature, the shorter is the time required for the elimination of the banded structure. The cooling rate has a considerable influence upon the formation of the banded structure. As the specimen cools quicker from the temperature above its critical range, the resulting banded structure becomes more indistinct. The formation of the banded structure by heat treatment depends greatly upon the heat treatment by which the specimen was previously treated. In the specimen, in which the banded structure was previously eliminated by high temperature treatment, the banded structure hardly reappears on the subsequent heating. HN (5a)

Bright-Annealing of Non-Ferrous Metals. A. G. ROBIETTE. *Metal Treatment*, Vol. 1, Summer 1935, pages 63-69. Exclusion of oxygen is not sufficient in itself to ensure bright annealing; water vapor, CO_2, and gases evolved by the metal may cause oxidation. The application of the laws of heterogeneous equilibria to the problem is reviewed, and their limitations pointed out. Chromium alloys can only be annealed in pure H_2 or, with short heating times, in N_2/H_2 mixtures. Traces of CO_2 are admissible. With Zn-containing alloys, only about 0.2% of oxidizing constituents may be present, although by adding a light hydrocarbon to the gas, formation of oxide by even appreciable amounts of CO_2 can be prevented, due to obscure reaction connected with the catalytic breakdown of the hydrocarbon. In annealing Ni, appreciable quantities of water vapor and CO_2 can be balanced by reducing constituents. Cu can be bright annealed in steam or CO_2, but traces of free O_2 must be excluded. Lubricants on the metal surfaces may cause difficulties. The costs and sources of the gases commercially used are discussed, and a description given of the main types of continuous and batch furnaces available. JCC (5a)

5b. Hardening, Quenching & Drawing

Importance of Surface Hardening by the Oxy-Acetylene Flame for the Machine Industry (Die Bedeutung der Oberflächenhärtung mit der Azetylen-Sauerstoff-Flamme für die Machinenindustrie). KESSNER. *Autogene Metallbearbeitung*, Vol. 28, Aug. 15, 1935, pages 244-247. The disadvantages of surface hardening by quenching and by case hardening (cementation, nitriding), particularly in large pieces, are discussed and a recent method is described by which the parts to be hardened are locally heated by the oxy-acetylene flame and quenched directly. The method can be applied to all steels which can be hardened by quenching in water. In order to avoid cracking the upper limit in C steels is about 0.5-0.6 C, while alloy steels can have less C; Cr-Mo steels seem to respond better to this treatment than C steels. Cast Fe can also be hardened by this method provided that it contains, besides graphite, 0.5-0.6% chemically bound C. The lower the C, the higher must be the hardening temperature (as determined by the Fe-C diagram). Burners used and examples are described. Ha (5b)

Heat Treatment of Steel Castings (Les Traitements Thermiques des Aciers Moulés). DAUBOIS. *Arts-et-Métiers*, Vol. 87, July 1935, pages 147-149. General metallurgical principles on which treatments are based. A long time annealing is necessary before any quenching treatment. Typical treatment is given. FR (5b)

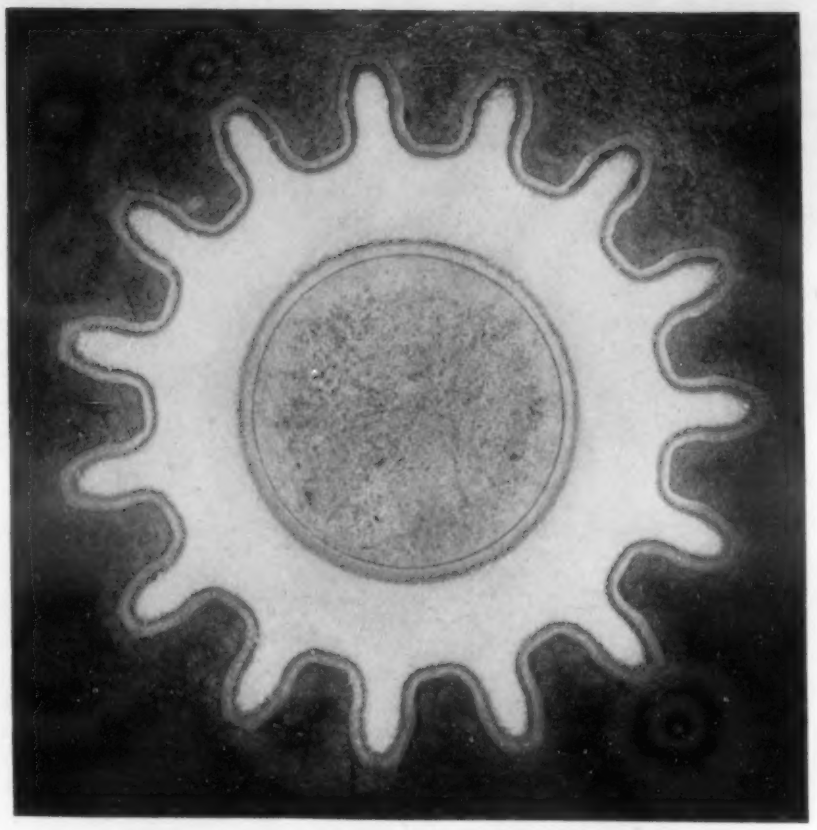
5c. Aging

Mechanism of $CuAl_2$ Precipitation in a Heat Treatable Copper Aluminum Alloy (Über den Mechanismus der $CuAl_2$-Ausscheidung in einer aushärtbaren Kupfer-Aluminium-Legierung). G. WASSERMANN & J. WEERTS. *Metallwirtschaft*, Vol. 14, Aug. 2, 1935, pages 605-609. Wire made from 5% Cu and 95% pure Al was recrystallized to produce a number of single crystals and these were aged at 200° and 300° C. X-ray photographs, taken from various angles, showed a wide variation in orientation of the precipitated $CuAl_2$ with respect to the Al solid solution in the samples aged at 300°. After aging at 200° diffraction rings were found which did not correspond to either the solid solution or $CuAl_2$, but to a new intermediate phase. It was tetragonal with $a = 8.2$ A.U. and $c = 11.6$ A.U. The orientation is such that the cubic and tetragonal axes of the phases are parallel to each other. The experiments indicate that the intermediate phase has the same composition as $CuAl_2$ but is structurally closely related to the lattice of the solid solution. It is evident that previous to $CuAl_2$ crystal precipitation several other stages are passed which are of importance in the hardening process. 10 references. CEM (5c)

Hardening of Solid Solutions (Age hardening). (Om fasta lösningars hårdnande ("tidshärdning")). C. BENEDICKS. *Jernkontorets Annaler*, Vol. 118, June 1935, pages 241-248. Author has previously developed the theory that hardening of metals which takes place on the addition of other components is due to the presence of supersaturated solid solutions. Where allotropy of the metal occurs, a further hardening may take place if the change to another allotropic modification reduces the solubility of the added component which is equivalent to an increase in degree of supersaturation. The theory is now elaborated to account for the increase in hardness which sometimes results even when no allotropic change is known to take place. Benedicks proposes that this may be explained by the growth of "crystallization centers." These increase with time while the degree of supersaturation falls, and the actual "age hardening" effect is the sum of the two. The point of view advanced is a more precise statement of Merica's view that "some structural alteration other than precipitation" augments the hardness (Transactions American Institute Mining & Metallurgical Engineers, Vol. 99, 1932, page 13). The presence of small amounts of a third component often promotes the growth of "crystallization centers" and thereby produces a greater hardness. HCD (5c)

5e. Carburizing

Case-Hardening Steels. C. C. HODGSON. *Metal Treatment*, Vol. 1, Summer 1935, pages 82-87. The properties of alloy case-hardening steels are described, and their heat-treatment and applications discussed. The effects of composition, Mn content, quenching temperature and quenching media on core strength are summarized in tabular form. It is emphasized that direct quenching or, with some alloy steels, air cooling, from the pot, which prevents separation of cementite in cellular form, is generally to be preferred to box cooling, and usually leaves both case and core in such a condition that only one heat-treatment is required, the refining treatment being eliminated. With alloy steels, higher quenching temperatures can be used with advantage without causing excessive grain growth and there is much latitude in the time which can elapse between removal from furnace and quenching. Tempering is of value chiefly in toughening the case and reducing the production of "crazy cracks" in grinding. JCC (5e)



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1 **Case Hardening (La Pratique de la Cémentation).** *Métaux et Machines (Science et Industrie)*, Vol. 19, June 1935, pages 205-207. (A) Case hardening in solid media. (1) Preparation for operation: Characteristics required for carburizing products are reviewed. Pots for case hardening have a short life when they are of mild steel, pots made of heat resisting steels of the Ni-Cr type are economical despite their high cost because they have a much longer life. C steels are used when great toughness is not required. Ni steels (2-6%) are resorted to when this toughness is essential. A Cu coating of sufficient thickness is adequate for preventing hardening of given portions of the pieces. (2) Control of operation: Steel test bars are put in the pots in contact with the pieces. During operation a bar is removed at intervals and broken to control depth of hardening. Temperature of case hardening must not exceed 950° C. (3) Heat treatment after case hardening: The following is advocated: A first quench at 875°-900° C. for refining core of the pieces. A second quench at 800° C. to obtain desired superficial hardness. Direct quenching from case hardening furnace is said to be a bad practice. To suppress stress a temper at 170°-180° is sometimes resorted to. (B) Case hardening in liquid media: This process shows many advantages over the former but also some disadvantages among which brittleness of hardened layer can be pointed out. Media are mixtures of NaCN and NaCl or Na_2CO_3. Pots must be heated at 900°; they are made of mild steel, calorized steel or Ni-Cr steel. Cast Fe is rapidly corroded. Common temperature of case hardening is 850° C. In this case, quenching can be made directly from the furnace. (C) Last section reviews difficulties which are met in case hardening and control testing of case hardened parts. FR (5e)

2

3 **Efficiency of Various Oils as Carburizers.** B. M. Suslov. *Metal Progress*, Vol. 28, July 1935, page 53. Activity of linseed oil as a producer of carburizing atmosphere led to assumption that complex O_2 bearing molecules were most active in producing good carburizing atmosphere and trial of HNO_3 treated gasoline showed as a very active and cheap source of carburizing atmosphere. WLC (5e)

5f. Nitriding

4 **Nitrogen Absorption by Iron During Fusion Welding and the Iron-Nitrogen Diagram (L'absorption de l'azote par fusion du fer dans l'arc et le diagramme fer-azote).** A. Portevin & S. D. Seferian. *Genie Civil*, Vol. 106, Jan. 19, 1935, page 67. See *Metals & Alloys*, Vol. 6, Aug. 1935, page MA 321L/10. JDG (5f)

5 **Steels Manufactured in France (Les Aciers de Fabrication Française).** *Métaux et Machines (Science et Industrie)*, Vol. 19, June 1935, pages 213-217. Deals with nitriding steels produced by Aubert et Duval. Discusses composition, physical properties, heat treatment, mechanical properties at room and high temperatures, machining, and uses. FR (5f)

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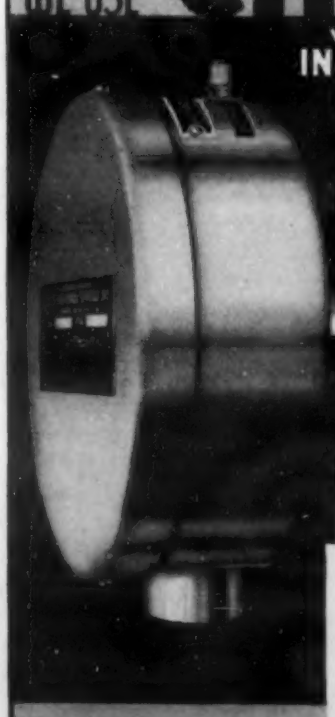

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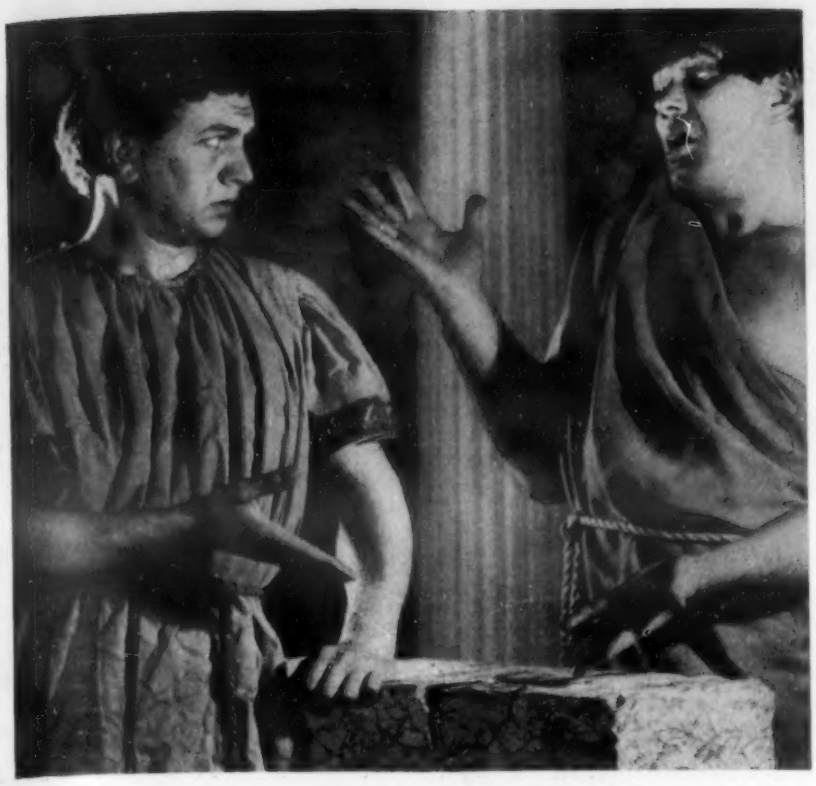

Θραύω

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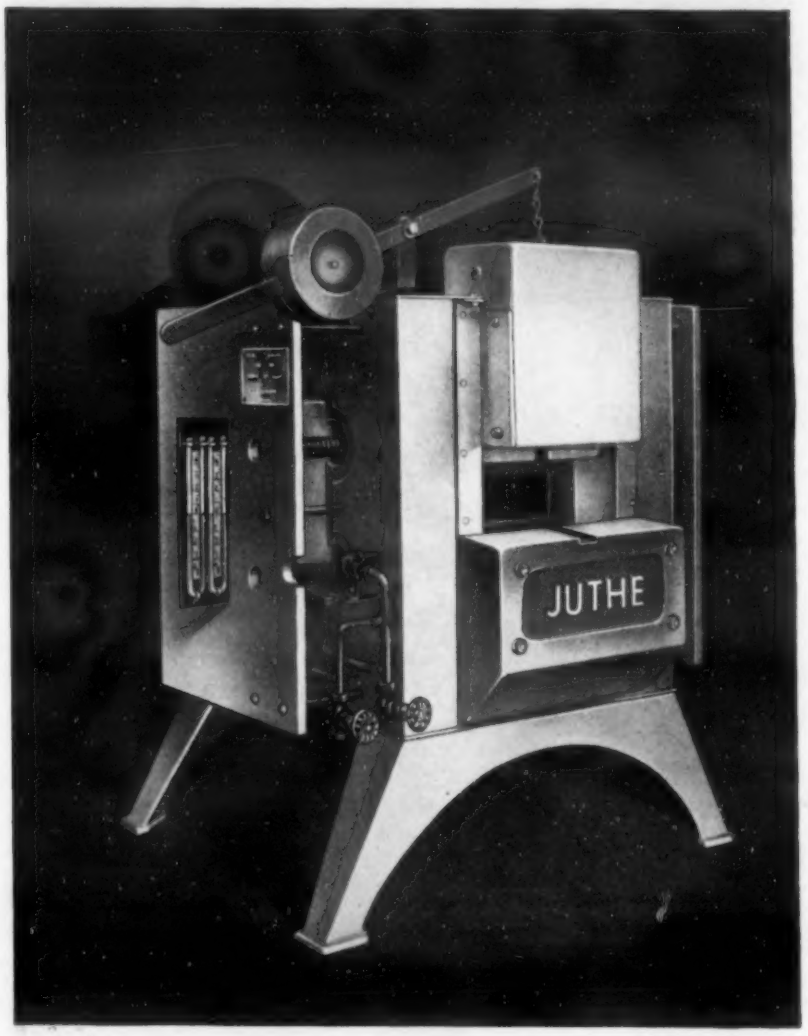

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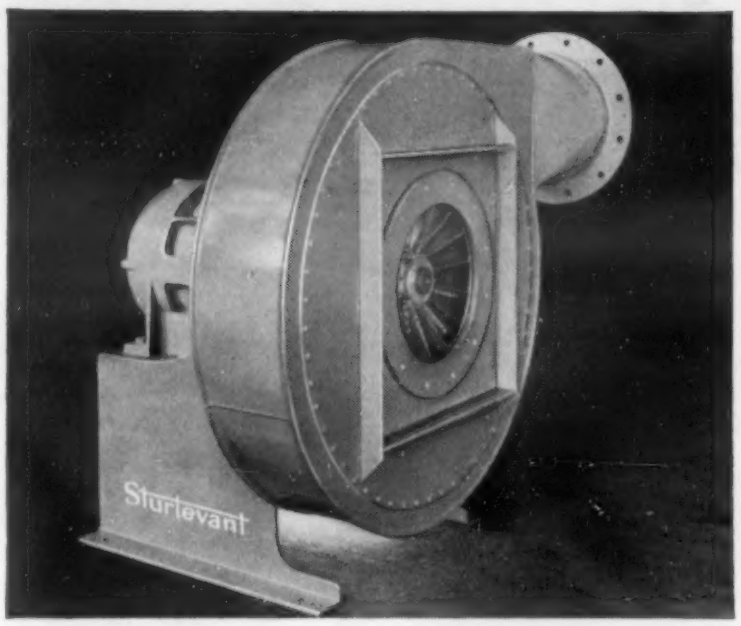

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6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

1 **The Development of Gas as a Fuel.** JOSEPH H. BANKS. *Commonwealth Engineer,* Vol. 22, May 1, 1935, pages 343-346. The use of gas in industry has increased tenfold in some places. Gas has many advantages to offer, particularly over solid fuels, such as evenness of heat, ease of control, saving of labor and elimination of storage. Among the applications of gas heating in engineering fields, illustrated reference is made to a tube welding furnace, forging and heating of steel, heat treatment of non-ferrous metals (bonderizing tanks, annealing of sheet and strip Cu, Al-pistons), oxy-coal gas cutting, cleaning bath, metal melting and oven for japanning and enamelling. Concerning oxy-coal gas and oxy-ferrolene (mixture of 1 gal. ether to 1200 ft.³ coal gas) steel up to 36" is being cut at equal cutting speed and 30% less cost than with acetylene. It is less dangerous to use as the flame is not incandescent and is not injurious to the eyes. WH (6)

2 **Electric Melting Furnaces for Iron (Elektrische Schmelzöfen für Eisen).** H. NATHUSIUS. *Elektrowärme,* Vol. 5, Aug. 1935, pages 193-198. Constructional, metallurgical and electrical questions involved in the operation of arc and induction furnaces are discussed; these 2 types are almost exclusively used for melting in industrial furnaces. Typical data for a 4-ton induction furnace are: melting time for dense scrap, 100-120 min., time for working one charge (in a basic furnace) 2¼ hrs., energy consumption 560 kw. hr./ton alloy steel. An arc furnace of 7½ tons needed 825 kw. hr./ton alloyed steel; charging required 3 min., melting 2 hrs., electrode consumption (graphite electrodes) 6.2 kg./ton steel. The furnace cover lasted 55-66 charges of alloy steel in the basic process. The various features in favor of and against the two types are discussed; the induction furnace, however, in combination with arc heating may be the future type of melting furnace. Ha (6)

3 **The Burning of Magnesite Bricks. Part II.** J. H. CHESTERS & C. W. PARMELEE. *Transactions of the Ceramic Society,* Vol. 34, Mar. 1935, pages 203-218. A test piece mold designed to give pressure-compression curves up to 50,000 lbs./in.², and a modified reaction expansion apparatus for work at 1500° C. are described. By using a grading of the 70:10:20 type, high molding pressure, and an addition of mucilage, unfired test pieces of electrically fused magnesia having porosities as low as 15.5% were obtained. The pressure-compression curves of the materials examined all showed a fairly rapid falling off in the rate of compression with increasing pressure. GTM (6)

4 **Combustion, Heat Treating Equipment Aims at Higher Quality, Lower Cost.** FRANK H. ADAMS. *Steel,* Vol. 97, Aug. 12, 1935, pages 44-45. Development of controlled atmosphere furnaces has made much existing equipment obsolete because of its inability to produce a satisfactory product. Use of new equipment reduces costs. Gives some examples of use of controlled atmospheres. In the case of equipment, such as soaking-pits, it may be preferable to install a new pit rather than repair or rebuild an existing one, as the cost may not be appreciably more and all the advantages of the most modern operation are gained. MS (6)

5 **Electric Furnaces (Elektrische Oefen) Fortschritte des chemischen Apparatewesens.** Part 4. Edited by H. ALTERTHUM. Akademische Verlagsgesellschaft, Leipzig, 1935. Paper, 7¾ x 11¾ inches, pages 145-176, 321-448. Price 28 RM.

This is the fourth of a 6 part summary of German patents on electric furnaces. The first section of this part, pages 145-176, continues a classification of patents by subject, covering smelting, carbon and carbides, and refractory materials. Patents are briefly listed with introductory historical comments. In the second section, pages 321-448, abstracts of all German patents that concern electric furnaces or their accessories are given in the order of their numbers. This part covers patents 420,703 (1925) to 478,675 (1929). Abstracts are quite complete, often with drawings. Undoubtedly, this compilation will be very valuable to those who may need to search German patent literature for information on electric furnaces. B. W. Gonser (6)-B-

6 **Forced Draught Coke-Fired Crucible Furnace.** *Engineer,,* Vol. 160, July 12, 1935, page 46. A new furnace made by E. Cecil Kny, London, requires only 20 min. preheating. Only 28 to 30 lb. of coke are necessary for a fusion and each melt never requires more than 45 min. About 1/3 of the furnace is sunk below the ground and about 2/3 down the inside of it is a patented grill, a square plate about 2" thick. Air vents are placed in the center of this and there are peripheral openings which allow an even distribution of air over the surface of the crucible. The furnace is made in 2 sizes, either for a 150 lb. charge or a 250-300 lb. charge. LFM (6)

7 **Metal Decorating Oven Incorporates Unique Features.** R. BRYON. *Industrial Heating,* Vol. 2, Aug. 1935, pages 429-434, 438. A furnace for decorating by enameling or otherwise coating or finishing metals under controlled heat and atmosphere conditions is described. Ha (6)

8 **The Developments in the Design and Operation of Open Hearth Furnaces.** R. S. BOWER. *Iron & Steel Engineer,* Vol. 12, July 1935, pages 413-424. Discussion of lines, fuels, reversing valves, meters, insulation and automatic control devices for open hearth furnaces. WLC (6)

9 **Reaction Temperatures between Various Types of Refractory Brick.** RAYMOND BIRCH. *Blast Furnace & Steel Plant,* Vol. 22, Dec. 1934, pages 720-721; Vol. 23, Jan. 1935, pages 90-92; Feb. 1935, pages 154-156; Mar. 1935, pages 220-221. Reprint of American Refractories Institute Technical Bulletin No. 52. Exhaustive test results are given of experiments which show that different refractories, such as silica, fireclay, high alumina, chrome, magnesite and forsterite, begin to react with one another in the furnace at temperatures between 1500° and 1700° C. The reactions may be so violent that rapid destruction of the material takes place. A number of tables show the effects and reactions. MS + Ha (6)

10

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Heat Calculations for Design and Operation of Furnaces (Wärmetechnische Rechnungen für Bau und Betrieb von Oefen). W. HEILIGENSTAEDT. Verlag Stahleisen, Düsseldorf, 1935. Cloth, 5½ x 8 inches, 186 pages. Price 11.50 RM.

This little book deserves much praise. It touches upon every engineering problem concerning furnaces in the iron and steel industry, including theory of heat, the heat balance with its various items, combustion (with space requirements for combustion), heat transfer, conduction of heat, with steady and with fluctuating temperatures, heating of the charge in furnaces, and finally heat interchange in recuperators and regenerators.

Heiligenstaedt has done much original work, and some of the chapters such as for instance the theory of the process of combustion and of the characteristic properties of burners are treated for the first time in any publication. Problems such as the cooling of ingots in their molds, and the effect of preheat upon heat requirements of open hearth furnaces are likewise treated. Theories which are well known, are not repeated; the final equation is, however, derived from them and is given conspicuously in large, heavy type.

The book is very concise and is possibly too much condensed to be of quick and immediate use to the designer or operator. In spite of the care used in presenting final, usable equations, careful study is required to apply them intelligently.

The book is heartily recommended to all furnace engineers who can read German. The beginner will find a wealth of information, and the man well advanced in the profession will find chapters that bring just what he needs to round out his knowledge. W. Trinks (6)-B-

Small Acid Open-Hearth Furnace Has One-Half Ton Capacity. J. TRANTIN, JR. *Steel*, Vol. 97, Aug. 12, 1935, pages 50, 52. Same as *Foundry*, Vol. 63, May, 1935, pages 22, 60. See *Metals & Alloys*, Vol. 6, Aug. 1935, page MA 322R/2. MS (6)

Gas Cleaning and Sludge Recovery System. FRED WILLE & ALBERT MOHR, JR. *Blast Furnace & Steel Plant*, Vol. 23, Aug. 1935, pages 529-532. Same as *Steel*, Vol. 96, May 13, 1935, pages 42-43, 56. See *Metals & Alloys*, Vol. 6, Aug. 1935, page MA 322R/4. MS (6)

Pulverized Fuel in the Metallurgical Industry. J. H. MAHLER. *Mechanical World & Engineering Record*, Vol. 47, June 14, 1935, pages 585-586. See Vol. 6, Aug. 1935, page MA 322R/4. MS (6)

Influence of Molten Aluminum on Fire Brick Lining of a Remelting Furnace. A. N. LYSENKO. *Legkie Metalli*, May 1935, pages 8-13. In Russian. In operation of electric resistance remelting furnace for Al lined with firebricks, slag crept upwards from the level of molten metal until it reached the roof. At the same time the heating coils failed being short-circuited through this slag. Chemical and microscopic investigation showed easy penetration of Al into porous firebrick. The metal reduced metallic elements in the brick and oxidized itself partially to Al_2O_3. The final product consisted of alumina containing SiO_2 and Fe_2O_3 holding Al in interstices. Its electric conductivity was high enough to cause short circuits. (6)

Note on the Failure of a Gold Fuse in Contact with Nickel-chromium Alloy. M. C. CAPLAN. *Journal Institute of Metals*, Vol. 57, June 1935, pages 331-333 (Advance Copy No. 707). The failure of a Au fuse to operate at the correct temperature was found to be due to diffusion taking place between the Au link and the Ni-Cr connection at a temperature of 950°-1000° C. An alloy of lower melting point is formed that offers little resistance to oxidation, and finally the Au link becomes disintegrated and converted to a cindery residue. JLG (6)

Measurement of Heat Conductivity of Refractory Materials at High Temperatures (Messung der Wärmeleitfähigkeit feuerfester Stoffe bei hohen Temperaturen). HUBERT FRANK. Müller & Schmidt, Coburg, 1935. 12 pages. Thesis. An apparatus was developed permitting measurement of heat conductivities of refractories up to 1400° C. Fireclay approaches a constant value as does silica to a lesser degree. Heat conductivity of magnesite and sillimanite decrease with increasing temperature and tend slowly to a constant value. The actual values of all these materials do not differ very much at the high temperatures. Sillimanite bricks of especially high porosity show a marked increase of heat conductivity at 600°-900° C. due to radiation and convection in the large pores. The heat conductivity of a material is reduced by addition of clay according to the amount of the latter. Ha (6)

Electrically Heated Muffle Furnaces (Elektrisch beheizte Muffelöfen). E. FÖLLINGER. *Elektrowärme*, Vol. 5, Aug. 1935, pages 198-201. Small types for laboratory work, shop and industry are described with particular regard to temperature control. Ha (6)

Replying to Six Pertinent Questions on Furnace Atmospheres. W. M. HEPBURN. *Steel*, Vol. 96, Mar. 11, 1935, pages 34-36. From a paper read before the American Gas Association. The fundamental factors involved in bright annealing are discussed; composition of atmosphere required for different materials (Cu, steel), and gases used and gas producers are described. The proper control of furnace atmosphere may eliminate pickling and sandblasting, and prevent material becoming decarburized in the heat treating process. Decreased inspection cost is another favorable point. MS + Ha (6)

Core Oven Thermal Efficiencies. C. F. MAYER. *Industrial Heating*, Vol. 2, Aug. 1935, pages 435-436. Tests made to determine the heat balance of mold and core drying furnaces showed the thermal efficiency to vary between 5 and 40% according to operating conditions. Ha (6)

Oxygen for Metallurgical Operations. *Engineer*, Vol. 160, July 5, 1935, page 10. Brief article commenting on the increased use of O in blast furnaces and open-hearth furnaces. Its use in blast furnaces corrects the slow action caused by moisture in the air. With open-hearth furnaces the use of O increases the heat by several hundred degrees which speeds up the reactions resulting in better output and quality. LFM (6)

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7. JOINING

7a. Soldering & Brazing

C. H. CHATFIELD, SECTION EDITOR

Experiments in Ready-to-Solder Wire. B. M. McCONNELL. *Wire & Wire Products*, Vol. 10, Aug. 1935, pages 313-315. Ready-to-solder wire consists of a tubular wire of solder, flux enclosed in the tube, and a conductor located in the flux. For delicate soldering operations, rosin is considered the best flux. Manufacturing processes are described. Ha (7a)

2

Thermal Joining. Soldering and Welding of Light Metals (Thermische Verbindungsarten. Löten und Schweissen der Leichtmetalle). L. ROSTOSKY. *Aluminium*, Vol. 17, June 1935, pages 316-319. The methods of soldering and welding, characteristics of the various procedures and fluxes used in them, and the present status of electric welding of Al and Mg alloys are reviewed. Al can easily be soldered or brazed. Ha (7a)

3

7b. Welding & Cutting

E. V. DAVID, SECTION EDITOR

The "Yankee's" Welded Steel Mast. *Shipbuilding & Shipping Record*, Vol. 45, June 6, 1935, page 631. A hollow steel mast 165 ft. 7 in. long and 18 in. at bottom, tapering to 7 in. at top, made in 4 sections, each section being made from a single sheet of steel, rolled to cylindrical shape with edges butted together and welded the entire length. The 4 sections when completed were welded together with a steel ring at the joint. JWD (7b)

4

New Drawing Symbols Formulated for Welds. *Machine Design*, Vol. 7, Apr. 1935, page 36. New fusion welding symbols submitted by the committee on nomenclature, definitions and symbols of the American Welding Society. WH (7b)

Welding Practice and Technique in the Construction of Ships of Moderate Size. N. M. HUNTER. *Iron & Coal Trades Review*, Vol. 130, May 3, 1935, page 767; May 10, 1934, pages 802-803. General review. Ha (7b)

5

Welding of Wires by Condenser Discharges (Schweissung von Drähten mittels Kondensatorenentladung). O. ZDRALEK & J. WRANA. *Elektrotechnische Zeitschrift*, Vol. 56, May 23, 1935, pages 579-580. Aperiodic discharges of condensers give very uniform welds in Cu, Fe, Al, constantan and nickelin, especially if welding is done in 2 stages so that the section of the weld is reinforced. Periodic discharges did not give good welds, and at least 30 volts must be applied to the condenser; the voltage depends on the metal. A list of voltages to be applied for different metals of different diameter is given. Condenser welding is considered as a special case of arc welding. Ha (7b)

6

Production Methods Used on Welding for Construction Purposes. G. E. DEATHERAGE & J. B. LATTERNER. *Journal American Welding Society*, Vol. 14, May 1935, pages 13-17. A review of schedules in installation of piping systems. See *Metals & Alloys*, Vol. 6, May 1935, page MA 194R/6. WB (7b)

Metallurgy of Oxy-acetylene Welding of Steel. J. H. CRITCHETT. *Journal American Welding Society*, Vol. 14, May 1935, pages 2-6. See *Metals & Alloys*, Vol. 6, May 1935, page MA 194R/6. WB (7b)

7

Contribution to the Study of Mechanical Properties of Electric Spot Welds (Contribution à l'étude des proprietés mécaniques des soudures électriques "par points"). E. J. L. DUSSOURD. *Revue de Metallurgie*, Vol. 32, Apr. 1935, pages 171-181; May 1935, pages 210-214. See *Metals & Alloys*, Vol. 6, Apr. 1935, page MA 150R/4. JDG (7b)

Symposium on the Welding of Iron and Steel. *Engineer*, Vol. 159, May 17, 1935, pages 506-509; May 24, 1935, pages 532-534; June 7, 1935, pages 599-600; June 14, 1935, pages 613-616. Includes discussion. From papers presented at the Symposium organized by the Council of the Iron and Steel Institute in coöperation with other technical societies. See also editorial entitled "The Art of Welding" commenting on this Symposium in *Engineer*, Vol. 159, May 17, 1935, pages 515-516. LFM (7b)

8

Rail Welding on American Railways. *Engineer*, Vol. 159, June 7, 1935, pages 585-586. Illustrated article describing the increasing use of welding, both thermit and gas, and a small amount of electric welding to produce long stretches of one-piece rails. On the Delaware and Hudson Railroad, out of 311 welded joints, only 3 failed. Three of these occurred in very cold weather and were due to stresses set up during the welding process. The others were defective welds. In Aug. 1933 this railroad had welded rails in lengths of 500 to 2800 ft. The advantages of welded rails are that track maintenance costs are lowered, a smoother riding track is produced, the rails have a longer life due to the elimination of worn joints and rail creeping is eliminated. The thermit pressure-butt process is used with a fusion weld of the base and the web of the rails and the heads are welded by pressure only. The molds are so designed that the slag from the thermit reaction completely surrounds the rail heads bringing them to welding temperature soon after the weld has been poured. See also editorial in *Engineer*, Vol. 159, June 7, 1935, page 595 commenting on this article and on the expansion of rails and on the fact that longer rails do not expand in the same proportion as shorter rails do. LFM (7b)

9

Titanium Minerals in Welding Rod Coatings. L. G. BLISS. *Foote Prints*, Vol. 8, June 1935, pages 10-15. The manufacturers of heavy-coated rod have abandoned the dip method of coating the rod and now produce the coatings with extruding machines. TiO_2 is important as an arc stabilizer in welding rod coatings and they may contain as much as 10 parts of TiO_2. Rutile is used for coating rods due to its much lower cost for the contained TiO_2 in comparison with 98% pure TiO_2. The max. efficiency of rutile as arc stabilizer is obtained as the particle size decreases but difficulties in the extruding machine increase as size goes to less than 325 mesh. Standardization has been made on 90% through 325 mesh. Most objectionable impurities in rutile for coatings is the S and P. But calculations are made showing that the probable S and P contents of the deposited metal due to the coating will be .00045% and .00015% respectively even though none is lost in the arc. Ilmenite is also used for coating where an oxide of Fe may be included. The cost of the contained TiO_2, usually about 58% is very low. Another possible substitute for pure TiO_2 in coating rods is the newly developed Ticasil which is a complex Ca Ti silicate mixture with typical analysis of: TiO_2—35.68%, SiO_2—30%, CaO—28%, Al_2O_3—2.5%, Fe_2O_3—2.5%, S—.042%, P—.043%, balance MnO, MgO, Y_2O_3. Preliminary tests indicate that with its use as rod coating a quieter arc, more brittle and easily fusible slag will be obtained. WB (7b)

"Weld It" Says Ford. D. G. BAIRD. *Mill & Factory*, Vol. 16, May 1935, pages 62-65, pages 171-173. At the River Rouge Plant at Dearborn, 5000 welding operations and 5 standard types of welding are used. Typical welding jobs, most of which are automatic, are shown in 9 illustrations. An interesting case shows a machine making 40 spot welds in one operation on inner door panels. Some of the largest machines in the world are shown. The oxy-acetylene process is used chiefly for tacking operations on the body, particularly at hard-to-get-at places that require fastening and reinforcing. WH (7b)

A Brief Survey of Welding Applications. L. M. ANGUS-BUTTERWORTH. *Welding Journal*, Vol. 32, Apr. 1935, pages 104-105. Advantages reviewed. WB (7b)

Welding for Construction, Production and Maintenance. A. M. CANDY. *Mill & Factory*, Vol. 16, Apr. 1935, pages 47-48, page 128. The evolution of welding in the United States is traced back to the World War. The main feature of the paper represents 7 characteristic photographs showing the scope of welding as applied to some recent structural engineering work. WH (7b)

The Repair of Damaged Cast Iron Machinery. *Oxy-Acetylene Tips*, Vol. 14, July 1935, pages 149-153. The former method of repairing cast Fe by fusion welding has been superseded almost entirely by bronze welding as this requires only low temperature and no melting of the base metal. Complicated castings always should be preheated. A number of examples are illustrated. Ha (7b)

Hard-Facing Machine Parts. *Oxy-Acetylene Tips*, Vol. 14, July 1935, pages 156-157. A few typical applications are described to illustrate economy of hard alloys welded on to wearing parts. Ha (7b)

Some examples of Arc Welded Ship Construction. D. ARNOTT. *Society of Naval Architects & Marine Engineers, Transactions*, Vol. 42, 1934, pages 194-261. See "Arc-Welding in Ship Construction," *Metals & Alloys*, Vol. 6, May 1935, page MA 194R/4. Ha (7b)

Technical Rules for Supplying Electric Apparatus for Arc Welding (Règles Techniques Relatives à la Fourniture des Appareils Electriques pour Soudure à l'Arc). *Revue de la Soudure Autogène*, Vol. 27, July 1935, pages 11-17. Tentative rules established by a Committee nominated by the French Welders' Society. Rules are under the 3 following headings: (1) General stipulations. (2) Technical conditions. (3) Acceptance tests. FR (7b)

Specifications for Added Metals Used in Oxy-Acetylene Welding (Specifications Relatives aux Métaux d'Apport pour Soudure Oxy-Acétylènique). *Revue de la Soudure Autogène*, Vol. 27, July 1935, pages 2-10. Tentative specifications just established by a Committee composed of leading engineers of the French welding industry. The specifications are divided as follows: (1) Aim and application of specifications and generalities about added metals. (2) Added metals for welding steels. (3) Added metals for welding cast Fe. (4) Added metals for bronze welding. (5) Added metals for welding of Cu, brass and bronze. (6) Added metals for welding Al and light alloys. (7) Added metals for miscellaneous metals and alloys. FR (7b)

Experimental Road Incorporating Welded Rails of 30 m. Length (Versuchsstrecke für geschweisste 30 m. Schienen). *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 89, Dec. 1, 1934, page 438. Note on experiments of the German Reichsbahn with 30 m. rails welded together and submitted to heavy traffic at 120-150 km./hour. If the new permanent way turns out satisfactorily, it will be used in all "FD" tracks (long-distance express tracks) in Germany. WH (7b)

7c. Riveting

Determination of Stresses in Riveted Joints (Bepaling van de spanningen in klinkverbinding). J. R. J. VAN DONGEN. *Polytechnisch Weekblad*, Vol. 29, Apr. 25, 1935, pages 257-259; May 2, 1935, pages 276-279; May 9, 1935, pages 298-300. Reports on recent experiments carried out at the Technical College of Delft (photo-elastic tests) and the N. V. Philip's Gloilampenfabrieken Eindhoven (pressure tests) with the object of accurately determining the occurring stresses and their distribution in such types of riveted joints as are applied to boiler plates. Faulty constructions were also investigated in order to study the effects when exceeding the yield point. WH (7c)

10

8. FINISHING

H. S. RAWDON, SECTION EDITOR

Surface Protection of Aluminum and Aluminum Alloys (Oberflächenveredlung von Aluminium und Aluminiumlegierungen). G. ELSSNER. *Chemiker-Zeitung*, Vol. 59, Mar. 13, 1935, pages 213-215; Mar. 20, 1935, pages 235-237. Al is more difficult to electroplate than other metals. The usual procedure is first to clean with an organic solvent, then with a weak alkali or by an electro-cleaning process. The second cleaning process also etches the surface and aids in producing better adherence. Other etching solutions used are sodium zincate, at 30°-40° C., various acids, and HCl solutions of Fe, Ni and Mn salts. For pure Al, acid solutions with high metal content are used, for Al alloy acid solutions with low metal content. Al is usually Ni plated, sometimes followed by Cu, brass or Cr plating. If sodium zincate was used for etching a citric acid Ni bath is best, otherwise any Ni solution can be used. A high initial plating current should be used to prevent chemical reaction at the start. Another type of treatment of Al for protection against corrosion and for coloring consists in dipping in various hot solutions of salts the composition of which is not stated. The time varies from several minutes to several hours. Sometimes the parts are given a final dip in sodium silicate. The third type of surface treatment is electrolytic oxidation, known by the trade names Eloxal and Alumilite processes. Chromate, sulphate, oxalate and phosphate solutions are used with either d.c. or a.c. The current flow is in the opposite direction to that in plating and Al_2O_3 is formed on the surface with perfect adherence. Accurate temperature control of the solution is necessary. An even, uniformly thick film is produced and there is no difficulty with throwing power. The thickness depends upon the current and the time. The electrical contacts must be made solid. The parts are first cleaned with an organic solvent and then cleaned electrolytically or etched in a hot alkaline solution, rinsed, placed in the anodizing solution, rinsed, dipped in a coloring vat if desired, rinsed, and dipped in a sealing solution. The natural color of the film is almost white on pure Al, gray on alloys. A hard surface is produced which has good corrosion resistance especially against salt spray. The film is capable of absorbing oil, wax, and colors such as aniline dyes. It is harder than Cr plate and withstands 400° C. The treatment does not alter the strength, but lowers the elongation. CEM (8)

8a. Pickling

Diffusion of Hydrogen in Pickling of Iron Sheets (Beitrag zur Diffusion des Wasserstoffs beim Beizen von Eisenblech). H. BABLIK. *Korrosion & Metallschutz*. Vol. 11, Aug. 1935, pages 169-172. Hydrogen diffusing into Fe during pickling affects very noticeably the appearance of the subsequently galvanized sheets (e.g. "gray sheets."). Experiments and practical observations have shown that presence of S compounds in the pickling liquid increases the rate of H diffusion into Fe, under otherwise equal conditions several times. Pickling baths should, therefore be kept free of H_2S as much as possible to reduce damage by too much H absorption. Ha (8a)

Use of Inhibitors in Preventing Corrosion by Acids. I. V. A. WARDELL. *Chemical Engineering & Mining Review*, Vol. 27, May 8, 1935, pages 286-290. Inhibitors are listed as: glue, gelatine, starch, yeast, pyridine, quinoline, naphthalene, sulphonic acid, anthracene oils, glycerine, aldehydes, hydroxylamine, alcohols and ketones, sulphite pulp liquor, trithioformate, carbon sulphide, derivative of a reaction product of an aldehyde and a guanidine and thiourea compound, As, Sb, $SnCl_2$, and NaCl. The effectiveness of NaCl as an inhibitor can be shown in describing the cause of inhibition (generally regarded as an adsorption mode of action). WHB (8a)

Modern Acid Handling Methods Lower Pickling Costs. J. R. HOOVER. *Wire & Wire Products*, Vol. 10, Sept. 1935, pages 407-410, 451. Improvements have been made in recent years in methods of handling acid in pickling of steel which have resulted in reduction of acid leakage and shut-downs and in improved working conditions generally. Ha (8a)

Acid Cleaning and Material Handling of Rods and Wires. F. A. WESTPHAL. *Wire & Wire Products*, Vol. 10, Sept. 1935, pages 401-405. The chemical reactions during cleaning with H_2SO_4, purpose of inhibitors, and the practical operation of cleaning processes are explained and some cases of failures discussed. Proper construction of cleaning tanks, especially to allow for expansion and contraction by temperature changes in the operation, is of great importance. Ha (8a)

8b. Cleaning, including Sand Blasting

Cleaning Metal Surfaces. C. F. SCRIBNER. *Industrial Finishing*, Vol. 10, June 1934, pages 12-14. Dirt, grease and old finish are removed by the "burn-off" process or by chemical cleaners. Rust is removed by wire brush, sand paper, sand blast or chemicals. Special solutions are used for removing cutting compounds and lubricants. JN (8b)

Baked Finishes on Die Castings. C. F. SCRIBNER. *Industrial Finishing*, Vol. 10, Feb. 1934, pages 39-40. Difficulties in finishing castings of Al, Zn, Pb or Sn are greatly reduced by a preliminary cleaning by sand-blasting or a weak caustic solution at 160° F., followed by preheating at 15° to 25° F. above the baking temperature. JN (8b)

Use of Inhibitors in Preventing Corrosion by Acids. II. V. A. WARDELL. *Chemical Engineering & Mining Review*, Vol. 27, June 8, 1935, pages 321-323. A résumé. Weight for weight As has much greater inhibiting power than the best organic inhibitors. Inhibitors are adsorbed on the protected surface. Inhibition depends on equilibrium between As deposited on the metal surface and in solution. A bibliography of 25 references is appended. WHB (8b)

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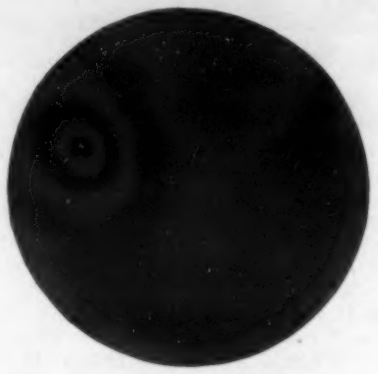

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8c. Polishing & Grinding

Modern Rotary Nickel Plating: Preparatory and Finishing Treatments (Moderne Trommelvernickelung, deren Vor- und Nachbehandlung). FRITZ SCHÄFER. *Metallwaren Industrie & Galvano-Technik*, Vol. 32, Dec. 1, 1934, pages 515-516. Before plating, the objects are placed in an octagonal drum with sand, gravel, waste emery and acidified water which is rotated for a few days. After thorough washing, further grinding with a special grinding powder mixed with clay is carried out in the rotating drum. This is followed by 2 pickling operations in (A) 1 liter conc. H_2SO_4 (40°Bé), 40 g. graphite, 8 g. NaCl and (B) 1.25 liter commercial H_2SO_4 (66°Bé.) 1 liter conc. HNO_3, 30 g. graphite. After rinsing, finish polishing is secured with drums filled with steel balls and jewellers' rouge, and in the case of case-hardened objects with scrap leather, Vienna lime and rouge. Data on the subsequent Ni plating solutions are given. The plated objects are dried in saw dust and rinsed with hot water containing some lime. A bright surface finish is secured in rotating drums filled with saw dust and polishing rouge or steel balls and jewellers' rouge. EF (8c) 1

Norbide (B_4C)—A New Abrasive. *Iron & Coal Trades Review*, Vol. 131, July 12, 1935, page 54. Material contains 78.22% B and 21% total C and has an average modulus of rupture in compression of 260,000 lbs./in.² whereas dense SiC has only 82,000 lbs./in.² The average coefficient of linear expansion is 0.45×10^{-7} per degree C. (0.47 for SiC) in the temperature range of 25°-800° C. It is made of C (coke) and boric acid. As powder, it is an extremely hard abrasive and is used in lapping jobs and replaces diamond dust; it can be molded into grinding wheels, extrusion dies, bearing material in instruments, or thread guides in textile machinery. Ha (8c) 3

Laps for Die-finishing. WESLOW. *American Machinist*, Vol. 79, May 22, 1935, pages 396-397. Some practical hints are given for lapping as a finishing process. Ha (8c)

Grinding Automotive Crankshafts. EDWIN BREMER. *Abrasive Industry*, Vol. 16, May 1935, pages 8-10. Details of grinding operations, tolerances and wheel grades given. WB (8c) 4

Molecular Roughness and Surface Structure (Molekulare Rauhigkeit und Oberflächenstruktur). HANS FUNK & HANS STEP. *Kolloid Zeitschrift*, Vol. 70, Jan. 1935, pages 109-119. Literature review based on 95 references. A great part of the paper is devoted to the surface structure of metallic materials; investigations of Perrin, Thomson, Kirchner, Steinheill, Beilby, Boas & Schmid, and Raether are stressed. EF (8c) 5

8d. Electroplating

Current Losses in Electroplating Industry (Verlustquellen in der Galvanotechnik). *Metallwaren-Industrie & Galvano-Technik*, Vol. 32, Oct. 15, 1934, pages 449-451. Detailed discussion on the economic use of electricity in plating shops emphasizing the various sources of current losses. EF (8d) 6

Corrosion Protection and Adherence of Metallic Coatings (Korrosionsschutz und Haftintensität von Metallüberzügen). *Metallwaren-Industrie & Galvano-Technik*, Vol. 32, Oct. 1, 1934, pages 429-432. Reprint from Billiter's new book "Prinzipien der Galvanotechnik" deals with (a) effect of the chemical nature of the basis metal and (b) effect of thermal expansion and pre-treatment. EF (8d)

The Relation of Coating Thickness to Outdoor Service Life on Zinc Alloy Die Castings. E. A. ANDERSON. *Monthly Review, American Electrochemical Society*, Vol. 22, Feb. 1935, pages 11-20. Samples of a die casting shape were Ni plated in 9 different types of solution, and under different conditions and then Cr plated. All samples were then mounted on the side of an automobile delivery truck in regular use to subject them to outdoor exposure. Conclusions based on inspection after one year's exposure were that coatings about .00015" thick are inferior to coatings .0003" thick and heavier in regard to corrosion resistance. Exposure test is to be continued until break downs occur. GBH (8d) 7

Influence of Additions to Nickel Baths on the Injurious Influence of Iron (Der Einfluss von Zusätzen zu Nickelbädern auf die Schädlichkeit des Eisens). E. RAUB. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 9, Apr. 1935, pages 1-8. The harmfulness of Fe in Ni baths consists in making the Ni deposits fine-grained and if high, in causing the deposit to spall off. Organic and inorganic additions which form complex compounds with Fe were investigated to determine whether the harmfulness of Fe can be prevented. It was found that this is achieved to a limited degree only. The spalling of the deposits is prevented if pH does not exceed 4 even though the Fe content is high. At the usual pH of 5-6 the effect is much less which is apparently due to the fact that with higher pH, colloidal complex compounds are easily formed in the deposit. The most effective of the additions were citric acid, the next, tartaric acid. Lactic acid, milk sugar and some other substances exerted a deleterious influence on the deposit. Ha (8d) 8

Concentrated Cyanide Copper Plating Baths. L. C. PAN. *Monthly Review American Electro-Platers' Society*, Vol. 21, Oct. 1934, pages 26-29. Experiments were performed to determine best solution composition from standpoint of electrode efficiencies, throwing power and plating speed. Following formula is recommended as being superior to acid Cu in the above respects. Cu cyanide 12, free cyanide by analysis 1.1, Na_2CO_3 10.4 oz./gal., 22-23° C, 18.5 amps./ft.² Anode efficiency 75.5%, cathode 95.0%. Discussion, G. Kutzen. Dec. 1934, page 19, states that Cu concentration in solution drops if free cyanide is less than 4 oz./gal.; also, carbonate should not exceed 5.6 oz./gal. for good results. GBH (8d) 9

Electrolytic Zinc Coating of Iron Barrels (Das elektrolytische Verzinken eiserner Barrels). A. WOGRINZ. *Metallwaren-Industrie & Galvano-Technik*, Vol. 32, Aug. 1, 1934, pages 338-339. Holds that electrolytic Zn coating of barrels compares favorably with the ordinary galvanizing process. Presents detailed costs on the electrolytic process under German economic conditions. EF (8d) 1

Determination of Nickel Content in Nickel Baths (Die Bestimmung des Nickelgehalts in Nickelbädern). E. WERNER. *Oberflächentechnik*, Vol. 12, May 21, 1935, pages 122-123. The importance is emphasized of controlling the Ni content of an electrolyte, especially in modern high-speed Ni plating baths. Although gravimetric or volumetric analysis may be employed, the colorimetric method is recommended because of its simplicity. Working prescriptions with standard solutions are given. Ha (8d)

Economical Viewpoints in the Electrolytic Galvanizing of Iron and Steel Strips (Wirtschaftliche Gesichtspunkte bei der elektrolytischen Verzinkung von Eisen- und Stahlbändern). HEINRICH MEYER AUF DER HEYDE. *Metallwaren-Industrie & Galvano-Technik*, Vol. 32, Sept. 1, 1934, pages 385-386; Sept. 15, 1934, pages 405-406. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 572. EF (8d) 2

Finishing Zinc and Aluminum Die Castings. JOSEPH FOX. *Product Engineering*, Vol. 6, June 1935, pages 216-217. Zn or Al-base die casting alloys are best suited for decorative or protective finishing. Pb and Sn-base alloys are less used when fine finishing is required, and Mg and Cu-base alloys have not yet been sufficiently developed for such purposes. Finishing consists in Cr plating particularly for Zn alloys. It may be deposited directly but more often an intermediate metal is used as base for the Cr. For castings exposed to moisture or varying temperature, Ni is used with a minimum thickness of 0.0002", or 4 g. Ni/ft.² For more exacting requirements 0.0003" thickness, 6 g./ft.² is used and when appearance is more important than cost, a primary coat of Cu of 0.0004" is used followed by a Ni coat of 0.0005-0.0006" on which the Cr is deposited. The latter is in all 3 cases about 0.00025" thick. Organic and inorganic finishing lacquers are used which all require baking. Al-base alloy castings can be treated in the same manner, or they can be polished and retain their own luster indefinitely by the thin surface film of Al oxide which acts like a lacquer. Anodic oxide finish has become very popular. All methods require careful initial cleansing of the surface before coating. Ha (8d)

Plating of Aluminum (Galvanisierung von Aluminium). JOHN FISCHER. *Siemens-Zeitschrift*, Vol. 15, Mar. 1935, pages 83-84. Although metals may be deposited electrolytically on Al and most of the Al alloys (with the exception of Mg alloys with more than 5% Mg), the question is raised whether such treatment is justified since Al produces a self-protecting layer, and also because of a high potential difference between Al and the deposited metal (Ni, Cu, etc.) Therefore, if the deposit is not impervious and the surface is kept wet with an aqueous solution, local elements are formed and corrosion takes place with white efflorescences of Al hydroxide. A few methods for depositing brass, Ni and Ag or Au are briefly described. Ha (8d)

The Thickness of Electrolytic Deposits and its Determination. (Gli Spessori dei Depositi elettrolitici e loro Determinazione). O. MACCHIA & V. P. SACCHI. *Industria Meccanica*, Vol. 12, Dec. 1934, pages 957-960; Vol. 13, Jan. 1935, pages 13-16; Feb. 1935, pages 109-113; Mar. 1935, pages 206-209; Apr. 1935, pages 319-323; May 1935, pages 406-409. The protective value of electrolytic deposits as a function of thickness is investigated, factors which influence uniformity of the deposit are discussed and means to determine the thickness described. The paper deals exhaustively with the various metals deposited on metallic bases, curves are given to determine required thickness for protection from corrosion, and tables give solutions for stripping deposits. The chemical method of determining the thickness is considered the most precise, since a definite area can be used from which the deposit is removed without destroying the deposit in other places; the deposit can easily be restored without leaving a trace. The method can be applied to objects of irregular form. For details the original must be consulted. 49 references. Ha (8d)

Accelerated Tests of Nickel and Chromium Plating on Steel. P. W. C. STRAUSSER, A. BRENNER & W. BLUM. *Monthly Review American Electroplaters' Society*, Vol. 22, Jan. 1935, pages 28-37; *Metal Industry*, N. Y., Vol. 33, Mar. 1935, pages 91-94. See *Metals & Alloys*, Vol. 6, Mar. 1935, page MA 196R/5. GBH + PRK (8d)

Specifications for Anodic Deposits. S. WERNICK *Paper* read before the *Electrodepositors' Technical Society*, Mar. 27, 1935, pages 85-96. The 2 methods of writing specifications are pointed out: process specifications define methods by which the deposits are produced whereas requirement specifications define the properties of the deposit. Latter is also known as a "purchase specification." For Zn, the first type is represented by specifying use of sulphate or cyanide solution depending on whether appearance, or good throwing power, is desired. In the second type, the coating must meet such requirements as (1) Satisfactory appearance, (2) adequate thickness or weight, (3) reasonably uniform distribution, (4) good adherence to the basis metal, (5) adequate protection of the basis metal against corrosion. Suggested specification for Cd requires a minimum thickness of .00023". GBH (8d)

Specifications for Cathodic Coatings. C. F. J. FRANCIS-CARTER. *Paper* presented before the *Electrodepositors' Technical Society*, Mar. 27, 1935, pages 69-84. Strongly recommends that specifications be based on agreement between plater and purchaser. Suggestions as to methods of specifying properties ordinarily difficult to measure and express, are given; thus the use of a standard sample for luster and appearance; scratch and bending tests for adhesion. Some existing specifications are mentioned. French railway requirements for coated steel are: .0006" Cu plus .0004" Ni, or .0006" Ni and Cu plus .0004" Ni. GBH (8d) 10

Copper Plating Aluminum. *Machine Design*, Vol. 7, May 1935, pages 21-22. Note on recent German process for Cu plating Al. Following steps are taken: polishing with abrasive, immersion in bath to remove Al-oxide coating and also produce thin Cu-coat, rinsing in plain water, rubbing with woolen cloth and second Cu-plating to any desired thickness. WH (8d)

8e. Metallic Coatings other than Electroplating

1

Practice of Lead-coating (Aus der Praxis des homogenen Verbleiens). ERNST GREGER. *Der Autogen-Schweisser*, Vol. 8, June 1935, pages 62-65. The initial cost of this process of "wiping" is more than for Pb lining but it can be applied to vacuum vessels without subsequent separation of the Pb coat and steel backing. It can also be repaired easily when worn out. The steel is pickled and tinned first before Pb is melted onto the work. Pb coats of 1-10 mm. thickness are secured. Typical wiping jobs are illustrated. WH (8e)

2

The Institution of Civil Engineers. *Engineer*, Vol. 159, June 21, 1935, page 648. An account of the Annual Conversazione held June 12, 1935. Among the exhibits was one by Sherard Cowper-Coles who demonstrated the "Duraspray" rust-proofing process for application on steel *in situ*. LFM (8e)

What Considerations Must be Taken into Account in Galvanizing Plants? (Was ist bei Verzinkungsanlagen zu beachten?). H. MEYER AUF DER HEYDE. *Oberflächentechnik*, Vol. 12, Aug. 20, 1935, pages 195-197. Dimensions of galvanizing tanks for various pieces and for wires, amount of Zn required per hr., amount of heat to be supplied during operation and idle intervals, and practical arrangements for wire galvanizing are discussed. Numerical examples are given. Ha (8e)

3

Metallic Cementation by Means of Tin Powder. TSUTOMU KASE. *Kinzoku no Kenkyu*, Vol. 12, Apr. 1935, pages 210-219. In Japanese. With the use of commercial Sn powder the cementation of Sn into Fe, Cu, and Ni at various temperatures between 300°-1100° C. was investigated. The thickness of the surface layer of the cemented specimens was measured and microscopic and chemical analyses, as well as corrosion tests with some acids and water were carried out. Following facts were established:—Diffusion of Sn into Fe, Cu and Ni occurs at a temperature of about 230° C. or near the melting point of Sn, and the rate of diffusion increases with rise of temperature. The rate of diffusion into Fe changes, however, almost abruptly at the A_3 point (906°). The relation between the weight increase of the specimen (ΔW) or the depth of penetration (P) and the absolute temperature of cementation (T) can be expressed as an exponential function, W (or P) $= ae.^{-b/T}$ Also, the relation between ΔW or P and the length of time for cementation (Θ) is given by the similar function. KT (8e)

4

5

Do's and Don'ts for the Sprayer of Metals. JAMES W. GIBBONS. *Power*, Vol. 79, May 1935, pages 230-231. Failures in sprayed-metal coatings usually result from insufficent metallurgical knowledge. The most common error is to apply dissimilar metals, i.e. metals of different potentials. Many mechanical failures are caused by burning the metal when spraying an almost finished job; bronzes and brasses are among the worst in this respect. Another mistake is to spray on a surface not thoroughly cleaned and roughened; sand blasting gives the best surface. All holes should be filled before spraying. Examples of successful jobs are described. AHE (8e)

Spangled and Non-Spangled Galvanised Finishes. *Sheet Metal Industries*, Vol. 9, Jan. 1935, pages 41-42. Abstract of an article by Imhoff in *Iron Age*. See "Sales Appeal of Hot-Dip Zinc Coatings," *Metals & Alloys*, Vol. 6, May 1935, page MA 197L/4. AWM (8e)

6

The Metal Spraying of Cores and Castings. A. ROGER. *Foundry Trade Journal*, Vol. 52, Mar. 14, 1935, pages 187-189. Paper read before the London branch of the Institute of British Foundrymen. Types of metal-spraying pistols, surface preparation, filling defects in castings, nature of coating, properties of sprayed metal, mold spraying, sprayed cores etc. are discussed. The author answers an objection to the use of sprayed metals on account of porosity; he states, that by careful manipulation it is possible to spray coatings of Zn, Pb and Sn that are definitely non-porous to liquids. The author has experienced difficulty in obtaining a non-porous coating of Al, brass and Cu, and the higher melting point metals. The microstructure of sprayed Fe shows that constituent particles vary considerably in size, but never exceed 0.01 mm. in diameter. Satisfactory results have been achieved in spraying green-sand molds with several different metals. AIK (8e)

7

Aluminum Coatings in Boiler Plants (Aluminiumschutzanstriche in Kraftanlagen usw.) M. REICHNER. *Feuerungstechnik*, Vol. 22, Apr. 15, 1934, pages 49-50. The advantages of Al as heat and corrosion-proof paint or metallic coating material are stressed. A mixture of Al powder and water-glass has been found recently to form suitable coatings for outdoor exposure. WH (8e)

8

Plating Glass with Metals by Aid of Vacuum. *Compressed Air Magazine*, Vol. 40, Apr. 1935, page 4708. An accidental discovery made during the study of electrical discharges in rarified gas led to the production of non-tarnishing mirrors. These originally consisted of Pt-coated glass. Of two methods developed, one is the so-called sputtering process and the other, the evaporation or vapor-plating process. In the latter case the metal is melted in a crucible while in the other the cathode in the arc provides the metal for the glass coating. Detailed description of both processes and their operation is given. An opaque coat, about .0001 mm., can be applied in a few minutes. Heavy metals such as Au, Pt, Ag sputter quickest in 10-15 min. Cu, Fe, Ni take twice as long, W still longer. Light metals (Al, Mg, Cr, Si) are more easily evaporated. The films obtained by sputtering and by evaporation adhere well, in fact better than chemically deposited ones. Au and Pt mirrors resist atmospheric corrosion but lack the reflecting power of Ag. Recent experiments of the Carl Zeiss Co. and of H. W. Edwards, University of California, showed that certain alloys are also suitable for vapor plating. WH (8e)

Preparing Machine Elements for Metal Spray Coating. CHARLES BOYDEN. *Steel*, Vol. 96, Feb. 18, 1935, pages 34-35. Similar to *Iron Age*, Vol. 135, Jan. 10, 1935, pages 35-37. See "Machine Element Coating," *Metals & Alloys*, Vol. 6, May 1935, page MA 197L/1. MS (8e)

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8f. Non-Metallic Coatings

Coloring of Iron in Sodium Hydroxide with Oxidizing Agents (Färbung von Eisen in Natronlauge mit Oxydationsmitteln). H. KRAUSE. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 9, Aug.-Sept. 1935, pages 45-52. Coloring of Fe in salt melts is very effective but the temperature is often not permissible if the hardness must not be impaired. Also the loss of salt by adherence of particles to the object on removal from the bath is fairly important. By the use of NaOH these disadvantages are avoided, it operates at 150°-200° C. The bath must, however, be covered when not in use as NaOH transforms into Na_2CO_3 by contact with CO_2 in the air; the carbonate can be precipitated by adding unslaked lime. A black color is produced in 15-30 min. in a solution of 400 g. NaOH in 600 g. H_2O with 10 g. niter and 10 g. sodium nitrite; the solution is heated to 120°-130°. Similar methods are described in DRP 292,603 (1915), 368,548 (1922), 391,800; brown and black in DRP 375,198 (1918), 376,669; yellow tones from light to bronze also in DRP 375,198, and 575,634, 613,762. A good solution for brown consists of 150 g. NaOH in 100 cc. of H_2O, addition of sodium nitrate and sodium nitrite gives brighter colors, nitrite alone gives spotty appearance. Several other additions, as litharge, KCN, urea, and ammonium nitrate gave good results. The colors are improved if the surface of the objects is first slightly pickled in very dilute acetic acid; HCl for pickling had a bad effect. After coloring, the articles should be rinsed in hot water and dried and then hot oil should be applied. Ha (8f)

Finishing Steel Barrels Used as Food Containers. F. L. PRENTISS. *Iron Age*, Vol. 135, May 2, 1935, pages 22-23, 82-84. Discusses fabrication and coating of barrels at the plant of National Barrel Co., Cleveland. Barrels are rolled to cylindrical shape on bending rolls and flash welded at rate of 4 ft./min. Recently developed sanitary lacquer is applied to inner surface of assembled barrels. The coating must be chosen to meet special requirements of the individual food products for which barrels are used. After baking, the exterior is enameled. All baking ovens are gas fired. VSP (8f)

Rust Protection by Blackening, Oxidation, Browning, etc. (Rostschutz durch Schwarzfärben, Brennen, Brünieren, usw.). E. WERNER. *Metallwaren-Industrie & Galvanotechnik*, Vol. 32, Aug. 15, 1934, pages 361-362. Chemical recipes for coloring steel at room and elevated temperatures. EF (8f)

Investigation on the Browning of Copper and its Alloys (Untersuchung über Braunfärbeverfahren für Kupfer und Kupferlegierungen). H. KRAUSE. *Metallwaren-Industrie & Galvano-Technik*, Vol. 32, Oct. 15, 1934, pages 453-454; Oct. 31, 1934, pages 471-472. See *Metals & Alloys*, Vol. 5, July, 1934, page MA 343. EF (8f)

9. TESTING

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

How Bronze and White Metal Bearings Fail. *Automotive Industries,* Vol. 73, July 13, 1935, pages 56, 61, (abstract from *Journal of the French Society of Automotive Engineers,* Jan. 1935). Failure in bronze is thought to be due to the large difference in coefficients of expansion of steel and bronze. Expansion of bronze may completely eliminate clearance and cause seizure. This may be prevented by using a very fluid oil, cooling it artificially and circulating it rapidly or by increasing the bearing clearance. Rod bearings are burned out due to adherence of oil to the bearing metal; with temperature rise above 260° F. cohesive molecular forces in soft anti-friction alloys apparently decrease rapidly and may become less than the counteracting force of oil adherence. Heat expansion is not considered of importance with white metal bearings. BWG (9a)

The Cause of Flakes (Die Entstehungsursache der Flocken). H. Bennek, H. Schenck & H. Müller. *Technische Mitteilungen Krupp,* Vol. 3, Apr. 1935, pages 74-86. See *Metals & Alloys,* Vol. 6, July 1935, page 290L/2. MG (9a)

The Conditions Producing Flakes (Die Entstehungsbedingungen der Flocken). E. Houdremont & H. Korschan. *Technische Mitteilungen Krupp,* Vol. 3, Apr. 1935, pages 63-73. See "Causes of Flakes in Steel," *Metals & Alloys,* Vol. 6, July 1935. page MA 290L/3. MG (9a)

Irradiation of Welds of Great Wall Thickness with Mesothorium Radiation (Durchleuchtung von Schweissungen grosser Wandstärke mit Mesothorstrahlung). R. Berthold & F. Stäblein. *Technische Mitteilungen Krupp,* Vol. 3, June 1935, pages 127-128. Wall thicknesses above 60-70 mm. cannot be irradiated by X-rays of 200 kv.; the γ radiation of radioactive elements must be resorted to. A mesothorium preparation of 3 mg. was used for inspecting a 100 mm. thick weld; an exposure of 13 hrs. at a distance of 1 m. gave a perfect picture which showed clearly the nature of the weld. The method is described in detail. Ha (9a)

Development and Status of Large X-ray Picture Methods in Testing Materials (Entwicklung und Stand des Röntgen-Grossbildverfahrens in der Werkstoffprüfung). A. Herr. *Messtechnik,* Vol. 11, July 1935, pages 129-131. The efforts to examine large areas of objects to be subjected to X-ray examination at one time instead of making several smaller exposures are discussed. Voltages of 400-600,000 v. are applied. Equipment and procedures are described. Ha (9a)

The Protection of Radium Workers. Herbert R. Isenburger, C. W. Briggs & R. A. Gezelius. *Metal Progress,* Vol. 27, June 1935, pages 60-61. See *Metals & Alloys,* Vol. 6, July 1935, page MA 290L/8. WLC (9a)

Utilization of Non-Destructive Testing Methods in Bridge Construction (Anwendbarkeit zerstörungsfreier Prüfverfahren im Brückenbau). *Organ für die Fortschritte des Eisenbahnwesens,* Vol. 90, Feb. 1, 1935, pages 57-58. Discusses magnetic tests and inspection by γ and X-rays. WH (9a)

The Application of the X-ray Crystal Analysis to Industrial Problems. Facilities provided by the National Physical Laboratory. British Library of Information, New York, 1934. 15 pages. Price 30c.

The pamphlet is a brief outline of what can be done on practical problems by X-ray diffraction. Problems studied at the N.P.L. are mentioned as examples, and the arrangements for undertaking such studies for industrial concerns are explained. The problems include: determining the orientation of synthetic jewels used as pivot bearings, determining fibre structure in various materials, correlating internal strain in certain steels with their heat treatment and magnetic properties, analysis of the scale from steel boiler tubes, identifying crystalline constituents in opal glasses, analysis of carbides in tungsten steels, and studies of electrodeposited metals. C. S. Barrett (9a)-B-

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Study of Properties of Welds by Means of the Micromachine (Etude des Propriétés Mécaniques des Soudures par la Micromachine). P. Chevenard. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 6, May-July 1935, pages 1760-1772. **Micro-mechanical Study of Welds.** *Welder,* Vol. 7, July 1935, pages 614-623, 640. The mechanical heterogeneity in a welded piece is discussed from the point of view of general mechanical tests of the weld and of the definition and characterization of welding qualities. In order to get an actual insight into the weld, micro-test pieces should be used as general tests on large test-pieces only yield the physical characteristics of the heterogeneous whole. Very small pieces judiciously selected and worked off from a welded structure (e.g. by trepanning), provide a correct picture of the quality of the weld. Methods of arranging such tests and evaluating the results are described in detail and illustrated. Taking of such small test pieces does not impair the structure; the small holes caused by it can easily be closed up afterwards by welding. 11 references. FR + Ha (9b)

Photo Elasticity Technique (Photo-elastometrie). J. L. De Roos. *Polytechnisch Weekblad,* Vol. 29, Mar. 14, 1935, pages 161-163; Mar. 21, 1935, pages 184-187. Underlying principles and apparatus for determination of stresses in solid materials by photo-elastic means are discussed. Bibliography is appended. WH (9b)

Compressive Strength of Crystals (Über die Druckfestigkeit von Kristallen). M. Schuler & A. Dimpker. *Zeitschrift für Instrumentenkunde,* Vol. 55, Feb. 1935, pages 63-70. In an Amsler testing machine, the compressive strength of sapphire balls and cones, diamond cones, ruby, quartz and steel balls was determined. Small cracks were noticed in the non-metallic materials at relatively low loads, although complete breakdown took place at much higher loads. Diamond was stronger than sapphire and ruby, while SiO_2 permits no definite conclusions. Roller bearing steel balls with a tensile strength σ_{max} = 250 kg./mm.², elongation = less than 1%, modulus of elasticity E = 22,000 kg./mm.², proportional limit = 90 kg./mm.², bending strength = 200 kg./mm.² were tested in relation to diameter r and load P. The balls cracked into 2-3 pieces as demanded by Hertz' theory. Based on 16 closely checking tests the empirical equation $P' = 500\ r^2$ was found. This agrees well with Hertz' law: $\sigma^3_{max} = 0.0588\ E^2.\ P'/r^2$. Using the above data $P' = 545\ r^2$. Hertz' theory does not only confirm the experimental quadratic equation, but also expresses the factor of proportionality in the correct magnitude. Contrary to steel, the investigated mineral crystals did not obey the Hertz' law. This is ascribed to the fact that the surface exerts a great influence in the case of single crystals, whereas the interior regions are more effective with poly-crystalline materials. A comparison between sapphire and steel balls shows that the former is more useful with diameters smaller than 0.2 mm. (maximum load = 1 kg.). Comparing steel balls with sapphire cones, the limit is 0.5 mm. which corresponds to a critical load of 14-15 kg. EF (9b)

Measurement of the Roughness of Surfaces (La mésure de la rugosité des surfaces). *Génie Civil,* Vol. 106, Jan. 5, 1935, pages 15-17. Brief survey of the methods used for determination of the roughness of surfaces. Among them are mentioned: cross sectioning of specimens before or after plating, making casts, bending over a sharp edge and projecting the edge so formed on a screen, sectioning after painting, grinding to increasing depth and examining the edge so produced and several methods involving the use of a sharp point travelling over the surface and properly connected with recording devices. The survey is based largely on the paper by H. Shaw, *Machinist,* Sept. 29, 1934. JDG (9b)

Elasticity Measurements by Means of Pendulums (L'Élasticimètre Pendulaire—Intérêt de son Utilisation au Contrôle de la Qualité des Fontes). P. Le Rolland. *Bulletin de l'Association Technique de Fonderie,* Vol. 9, May 1935, pages 148-155. Paper presented before the Association Technique de Fonderie, Feb. 20, 1935. An improved machine for determination of elastic modulus by the sympathetic pendulum method of Rolland and Sorin. The values so determined are described as the transverse modulus at the origin. Advantages of this method and examples of its use are given. WHS (9b)

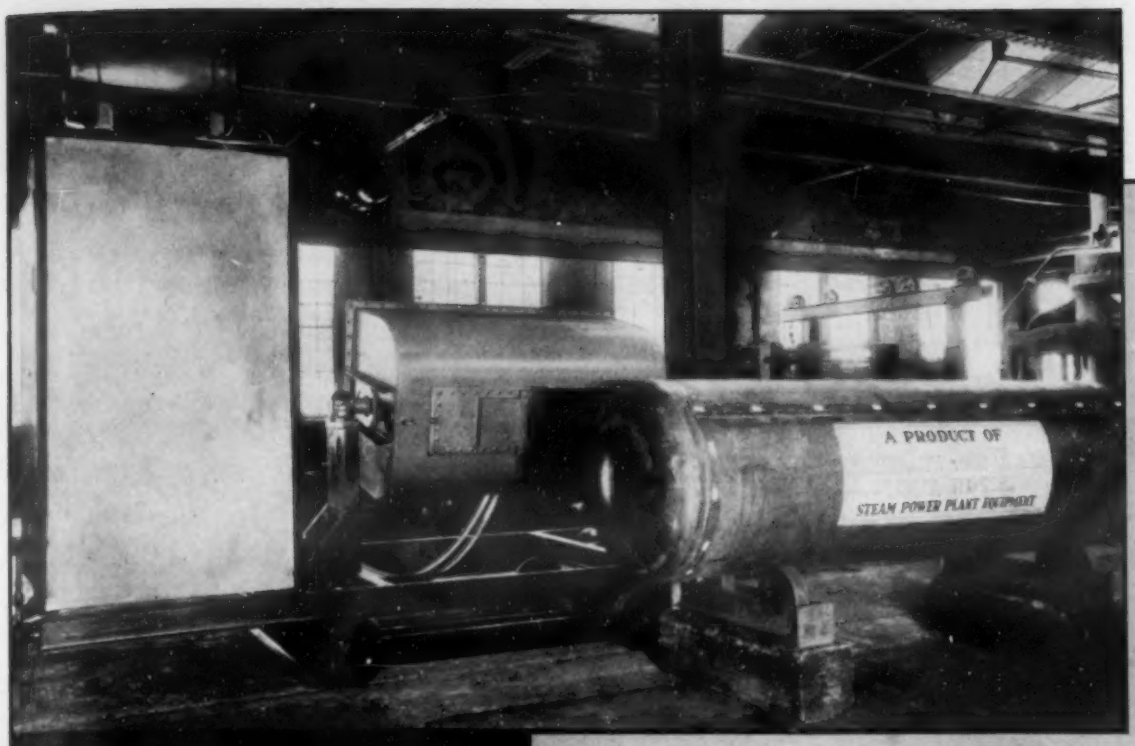
New Surface Testing Method for Corrosion Protection (Eine neue Oberflächenprüfmethode im Dienste des Korrosionsschutzes). A. Kufferath. *Korrosion & Metallschutz,* Vol. 11, June 1935, pages 133-136. A microscope is described which can be used by unskilled men in the shop to determine the surface quality of ground and polished surfaces during the manufacturing process by comparing the piece to be tested with a standard specimen. See also *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 22. Ha (9b)

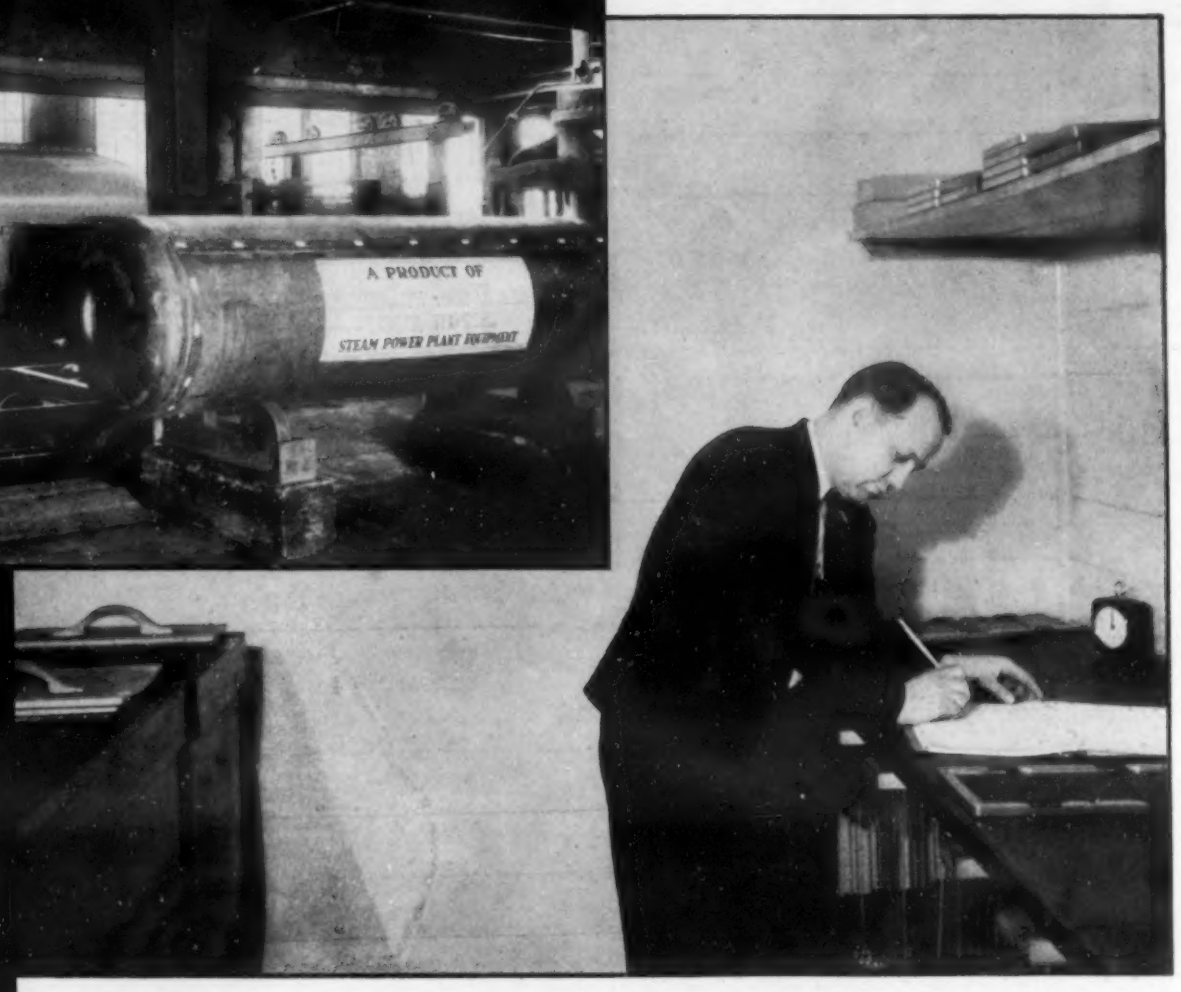
Bending Test and Resiliency Test of Metals (La Prova di Peigamento sui Metalli e la Prova di Resilienza). F. Figari. *Industria Meccanica,* Vol. 17, June 1935, pages 501-506. Present views to consider a resiliency test as sufficient for determining the structure are reviewed, but it is stated again that without a bending test no positive results can be derived. Exactly opposite results may be obtained due to temperature, i.e. a metal which proved to be superior to another at 15° C. may be inferior to it at —20° C. The bending test is considered by far the better. **Further Considerations on Bending and Resiliency Test (Altri Considerzioni sul Raffronto fra le Prove di Piegatura e le Prove di Resilienza).** St. Menghi. *Industria Meccanica,* Vol. 17, June 1935, pages 507-509. The views expressed formerly by the author that the resiliency test can give valuable information on the structure of a material is defended. Limitations and procedure are discussed briefly. Ha (9b)

Stresses in Railroad Track. Sixth Progress Report of Special Committee. *Proceedings American Railway Engineering Association,* Vol. 35, 1934, pages 66-308; *discussion,* pages 1148-1155. This voluminous report details the results of laboratory and track tests on rail joints and rails to determine the depressions, stresses, and moments involved; to relate these to the methods of support and to track conditions; and to study the influences of strength and stiffness of rail and conditions of the sub structure on the quality and stability of the track. Portions of metallurgical interest include accounts of the extensometers and magnetic strain gages used to measure changes in length of bolts and rails. JCC (9b)

Energy Input Held Constant in New Friction Material Testing Machine. Edward P. Culver & Joseph C. Elgin. *Automotive Industries,* Vol. 72, June 15, 1935, pages 802, 808. A machine for determining factors affecting the coefficient or friction, wear resistance, and effects of operating conditions on performance has been developed at Princeton University. Test temperatures are automatically kept constant regardless of changes in friction. Identical temperature-time conditions can be duplicated for comparing different materials. BWG (9b)

Commercial Testing of Engineering Materials. J. Trickett. *Mechanical World & Engineering Record,* Vol. 47, June 21, 1935, pages 603-606; June 28, 1935, page 632; Vol. 48, July 5, 1935, pages 3-5. Articles give essential information on the latest methods and machines. The first instalment deals with the test piece, testing machine, and making the tensile, compression and transverse test. The standard Erichsen and Olsen cupping tests are described in Part 2. Part 3 points out that impact testing clearly differentiates between heat treatment variations where the tensile test shows little difference. The Izod and Charpy machines are fully considered. WH (9b)





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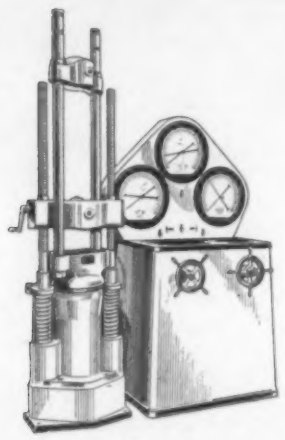

The wide use, in this country, of hydraulic testing machines has been a development of the past few years. There were, of course, a few outstanding precision testing machines having mutually independent load producing and load measuring hydraulic systems, such as those designed and built by A. H. Emery for the Watertown Arsenal and the National Bureau of Standards; but their cost limited their use to laboratories in which price was a secondary consideration.

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9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals.

1 **Fatigue Strength of Butt Welds.** B. P. HAIGH. *Welder*, Vol. 7, May 1935, pages 548-552. Although generally the stresses in buildings or bridges are limited to the elastic deflections and therefore butt or fillet welds give satisfactory results, V or double-V butt welds offer advantages over the 2 before-named welds in cases of doubtful stresses where fatigue fracture may be involved. Fatigue testing on welds is important; an endurance basis of at least 5 million cycles appears to be necessary for revealing the full effect of any flaws present although a basis of only 2 millions usually suffices for more homogeneous metals tested under direct pull and push as applied in the Haigh machine. A number of tests are described with alternating tensile and compressive stresses of equal and unequal amplitude. The conclusions drawn from these tests seemed to be in good agreement with practical experience, namely that a range of stress from zero to about 21,000 or even 22,000 lb. per sq. in. is required to break butt welds in mild steel plates even when gas holes and slag inclusions are present in large numbers. Lack of fusion constitutes the greatest danger in the use of welding for structures which have to carry live loads varying widely in magnitude. Ha (9c)

2 **Testing Cable Sheath for Fatigue.** C. H. GREENALL. *Wire & Wire Products*, Vol. 10, July 1935, pages 267, 269, 293. Describes laboratory methods simulating service conditions to determine the resistance of various cable sheathing alloys to fatigue. Ha (9c)

3 **Failures of Machine Parts and Means for Their Elimination. Fatigue of Metals and Fatigue Testing Machines for Metals (Les ruptures des pièces de machines et les moyens de les éviter. La fatigue des métaux et les machines d'essais à la fatigue).** L. PERSOZ. *Génie Civil*, Vol. 106, Mar. 16, 1935, pages 245-251; Mar. 23, 1935, pages 274-278; Mar. 30, 1935, pages 304-308; Apr. 1935, pages 328-330. Very extended summary of the published information regarding fatigue properties of metals. Fatigue testing machines are described devised by Haigh, Jasper, MacAdam, Schenck (widely used in Germany), Technical Section of French Aviation and by Trayvou. The latter is described in detail. The machine uses rotary flexion and automatic recording of the properties of samples. Comparison of results obtained with different machines is given. A summary of the opinions of the authorities regarding the relation between fatigue strength and mechanical properties, its variations with temperature, influence of notch effect is given. Corrosion fatigue is presented largely in the light of information obtained by McAdam, Mailaender and Ludwik. The means for prevention of fatigue failures are described on the basis of published data. JDG (9c)

4 **Fatigue Research on Steel Wire.** *Engineering*, Vol. 139, June 7, 1935, pages 603-604. Editorial reviewing recent work published on fatigue strength of steel wire. LFM (9c)

9d. Magnetic Testing

L. REID, SECTION EDITOR

5 **Gadolinium—A New Ferromagnetic Metal (Un Nouveau Métal Ferromagnétique, le Gadolinium).** GEORGES URBAIN, PIERRE WEISS & FELIX TROMBE. *Comptes Rendus*, Vol. 200, June 24, 1935, pages 2132-2134. Metallic gadolinium with impurities of less than 0.7% Si and 0.03% Fe was found to be ferromagnetic with a Curie point at 16 ± 2° C. FHC (9d)

6 **Powder Lines on Magnetized Ni Crystals (Pulverfiguren des Magnetisierten Nickelkristalls).** S. KAYA & J. SEKIYA. *Zeitschrift für Physik*, Vol. 96, July 25, 1935, pages 53-61. Photographs are given showing the variation in patterns that powder takes on the magnetized surface of thin sections of Ni cut from a single crystal parallel to the 100, the 110 and the 111 planes. FHC (9d)

7 **Magnetization Curves of Single Crystals of Iron (Über die Magnetisierungskurve von Eiseneinkristallen).** R. JAANUS. *Physikalische Zeitschrift der Sowjet Union*, Vol. 7, No. 3, 1935, pages 380-384. In German. It is experimentally shown that the conclusions of Hill (*Philosophical Magazine*, (7) Vol. 14, 1932, page 599, Vol. 18, 1934, page 539) regarding the magnetization curve of Fe single crystals do not hold true. EF (9d)

9e. Spectrography

8 **An Investigation into the Use of the Logarithmic Sector for the Quantitative Analysis of Precipitates.** E. G. KNOWLES & L. C. MARTIN. *Transactions Faraday Society*, Vol. 31, Feb. 1935, pages 502-508. Contains bibliography. The internal standards method was found to present undue difficulties as applied to determining K co-precipitated with Ba as SO_4. In studying the co-precipitation of Zn with Cu as sulphide, after standardizing for various lines, data are given using the lines Cu λ 4704 A.U., and Zn λ 4722 A.U. The amount of Zn in the precipitate is affected by the acidity of the solution. The minimum amount of Zn was co-precipitated when the % HCl was 4. PRK (9e)

9 **Arc Spectrum of Copper in the Infrared.** C. C. KIESS. *Bureau of Standards Journal of Research*, Vol. 14, Apr. 1935, pages 519-521. A survey of the arc spectrum of Cu out to the limit attainable photographically in the infrared has yielded about 30 new lines. All, except one, are accounted for as combinations between previously known terms of Cu I. The results are summarized in a convenient table. WAT (9e)

10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

Electron Diffraction as a Method of Research. G. P. THOMSON. *Nature*, Vol. 135, Mar. 30, 1935, pages 492-495. A review of successful applications of the method, including the following: the surface layer of iron rust was found to be γ FeOOH, though the bulk of the rust was probably Fe_3O_4; an unidentified oxide of Cu was found, not Cu_2O or CuO; silvered mirrors were found to become coated with Ag_2O when treated with aqua regia; the perfection of the surface layers of crystals has been studied without finding evidence for an inherent "coarse structure"; the inner potential of numerous crystals has been determined; evaporated and sputtered films of metals are randomly oriented crystallites, but often recrystallize into oriented layers; oxide films on molten metals are often oriented; hexagonal Zn oxide forming on polycrystalline Zn modifies its lattice dimensions so that its basal plane conforms with that of the Zn; the orientation of Pb oxide has been followed during the freezing of molten Pb; the size of crystals smaller than 10^{-6} may be determined from the diffuseness of reflections; 3 researches have confirmed Beilby's amorphous layer on polished metals, and thin metallic layers deposited on these polished surfaces dissolve in them; the orientation of greases and graphite lubricants has been determined; no effects due to adsorbed gas layers on metals have been noted. 22 references. CSB (10)

Electrolytic Method for Obtaining Bright Copper Surfaces. P. A. JACQUET. *Nature*, Vol. 135, June 29, 1935, page 1076. A rapid, economical method of polishing Cu: rough-polish with emery paper, clean cathodically in alkaline solution, then make it the anode for 2 or 3 minutes in aqueous solution of orthophosphoric acid, 50% by volume of the commercial product. At a current density of 60 amp./dm.^{2} of the total surface (with artificial cooling to avoid too great a temperature rise) the scratches are completely removed, and specimen is ready for metallographic etch. CSB (10)

An Analytical Method for Determining the Preferred Orientations of Crystals in Mechanically Worked Cubic Metals. CARL B. POST. *Zeitschrift für Kristallographie*, Vol. 90, Apr. 1935, pages 330-340. In English. The experimental method of Davey, Nitchie & Fuller (*Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 89, 1930, pages 557-565) for the determination of preferred orientations of crystals in mechanically worked metals has been developed into a more rigid analytical procedure. The geometry involved in a study of the physical constants of the pin-hole X-ray apparatus together with the measurements of 2 diffraction patterns made in different directions across the sheet of metal is found to be sufficient to evaluate the equations for the determination of orientation in cubic metals. The work of Hollabaugh & Davey (*Metals & Alloys*, Vol. 2, Oct. 1931, pages 246-250; Nov. 1931, pages 302-313), on rolled Ag sheets is considered and their photograms evaluated in terms of the procedure given here. It is found that the unit cell in rolled Ag sheets is oriented in such a manner that the face diagonal of the basal plane makes an angle of approximately 22° with the direction of rolling. The range of preference is $\pm$ 15% with reference to the mean position. Hollabaugh reports 2 preferred ranges of crystallites in rolled Ag giving as a reason the necessity of explaining all of the spots on the photogram. Post shows that one of these orientations is sufficient to explain all of the spots, but since the 2 orientations are symmetrical with respect to the direction of rolling, one may be used as well as the other. EF (10)

Structure of Cd-base Antifrictions (Struttura delle antifrizioni al cadmio). L. LOSANA & C. GORIA. *La chimica e l'industria* (Italy), Vol. 17, Mar. 1935, pages 159-163. The alloys of Cd containing high Cu and Ag have been investigated by means of cooling curves, as well as micrographically, to determine the region of useful antifriction alloys. The best alloys are contained in the restricted region containing 0.2-0.3% Ag and 1.3-1.8% Cu. Increased Ag or lower Cu does not give as good results. AWC (10)

On the Theory of the Refractive Index of Crystals for Cathode Rays and the Breadth of Reflexion Lines. SEICHI KIKUCHI. *Scientific Papers Institute of Physical & Chemical Research, Tokyo*, Vol. 26, Mar. 1935, pages 225-241. In English. Mathematical treatment of the subject under the following heads: (1) solution of the wave equation in a crystal, (2) Bragg's case, (3) reflecting power, (4) breadth of reflection lines and refractive index. WH (10)

The Influence of Nonmetallic Inclusions Upon the Precipitation of Primary Cementite in Hypereutectoid Steels. E. G. MAHIN & E. F. LEE. *Transactions American Society for Metals*, Vol. 23, June 1935, pages 382-397. Paper read and discussed at A.S.M. Convention, 1934. See *Metals & Alloys*, Vol. 6, Feb. 1935, page MA 69. WLC (10)

Inner Potential of Zinc Blende. SHIZUO MIYAKE. *Scientific Papers Institute of Physical & Chemical Research, Tokyo*, Vol. 26, Mar. 1935, pages 216-224. In English. The author summarizes as follows: "The ambiguity left in the assignment of the orders of reflections to the cathode ray spectra due to the cleavage face of zinc blende is removed, and as a result, the fact that the anomalous phenomenon takes place in the lower orders for zinc blende also is confirmed. As the normal value of the inner potential of this crystal 12.18 volts is obtained." WH (10)

X-ray Study of Lüders' Lines and Strain Figures in Low Carbon Steel. ROBERT F. MEHL & M. GENSAMER. *Metals & Alloys*, Vol. 6, June 1935, pages 158-159. Describes method of detecting stretcher-strains in annealed low-C steel by X-ray methods. WLC (10)

On the Scattering of Fast Electrons by Crystals. N. PISARENKO. *Physikalische Zeitschrift der Sowjetunion*, Vol. 7, No. 1, 1935, pages 26-42. In English. The inelastic scattering of fast electrons is investigated theoretically. Confined to the simplified case of a cubic-crystal lattice composed of atoms of the same kind. EF (10)

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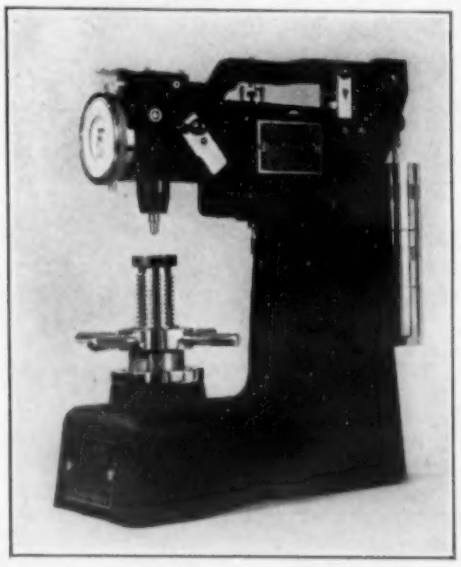

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11. PROPERTIES OF METALS AND ALLOYS

Brittleness in Ductile Engineering Materials. W. E. LEWIS. *Transactions Institution of Engineers & Shipbuilders in Scotland*, Vol. 78, May 1935, pages 444-484. Includes discussion. The value of the notched bar test in detecting brittleness in material which has good tensile test properties is described. The conditions which give rise to such brittleness are reviewed. Notch brittleness is found in unannealed steel castings, and in "dendritic" castings even after annealing. "Steads brittleness" occurs through grain growth when steel with less than .16% C is maintained at 600°-700° C. and may occur in the centre of bars cooled in piles. Mild steel is embrittled if quenched from 750° C. or is reheated to 150°-300° C. after stretching a small amount. "Temper brittleness" occurs if some Ni-Cr steels are slowly cooled, and some alloy steels become brittle when maintained at moderately high temperatures. Reference is also made to intercrystalline brittleness produced by the action of molten metals, season cracking, and "caustic embrittlement" in boilers. See also *Metals & Alloys*, Vol. 6, Aug. 1935, page MA 333L/2. JCC (11)

Vapor Pressure-Temperature Relation of Metals (Beitrag zum Stand der Dampfdruck-Temperaturabhängigkeit von Metallen). W. LEITGEBEL. *Metallwirtschaft*, Vol. 14, Apr. 5, 1935, pages 267-270. Sources of error in the methods for determining the boiling point of Pb and other metals used by the author, Fischer, and Baur and Brunner are discussed. Further tests by the author prove that the boiling point of Pb is above 1700°C. and that Cu boils at a higher temperature than Sn. Curves for the important metals showing the relationship between log p and 1/T are given. 10 references. CEM (11)

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

New Alloy Gives Hardness, Strength, Resists Corrosion. *Machine Design*, Vol. 7, May 1935, pages 31-32, page 69. Discussion on K-Monel. Typical analysis = 63.32 Ni, 30.84 Cu, 3.45 Al, 1.5 Fe, 0.5 Mn, 0.16 C, 0.2 Si, 0.005 S. Tensile strength over 160,000 lbs./in.², proportional limit = 100,000 lbs./in.², elongation = 15%, modulus of elasticity = 26,000,000 (in tension) and 9,500,000 (in torsion); Wire strength = 175,000-200,000 lbs./in.², endurance limit = 36,500 lbs./in.²; and 26,000 fully aged; impact value (fully aged) = 100 - 200 foot-lbs; corrosion resistant to "practically all acids, alkalis, salts, waters, food products, organic substances and atmospheric conditions. Applications pointed out: pump rods on ships, thin-walled cylinders submitted to high hydraulic pressure, balls to form valves. WH (11a)

Selenium and Tellurium: Their Properties and Uses. *Journal Society Chemical Industry*, Vol. 53, July 13, 1934, pages 616-617. General review of the occurrence, physical and chemical properties and uses of Se and Te. VVK (11a)

Reflection on Extremely Thin Metal Layers (Über die Reflexionsfaktoren sehr dünner Metallhäutchen). PIERRE ROUARD. *Zeitschrift für Instrumentenkunde*, Vol. 55, Feb. 1935, pages 86-87. **(Sur les facteurs de reflexion des métaux en lames très minces).** *Revue d'optique*, Vol. 13, 1934, pages 73-79. Au and Ag layers were deposited on glass by cathodic atomization and the light reflected from both the glass side and metal film side was investigated. Pt behaves similar to Au and Ag. See also "Reflecting Power of Very Thin Metallic Films," *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 275. EF (11a)

Magnesium-Cobalt Alloys. J. P. WETHERILL. *Metals & Alloys*, Vol. 6, June 1935, pages 153-155. 5 references. Data are given on Mg alloys with up to 4.79% Co. Sp. gr., f.p., hardness and microstructure are reported. A eutectic point at 636°C. and approx. 5% Co is indicated. WLC (11a)

Revision of the Atomic Weight of Tellurium. Part III. Analysis of $TeCl_4$ (Revision des Atomgewichtes des Tellurs. III Mitteilung. Analyse des Tellurtetrachlorides). O. HÖNIGSCHMID & H. BAUDREXLER. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 223, May 23, 1935, pages 91-100. Method of preparing $TeCl_4$ and the analytical procedures are given for determining Te atomic weight as 127.63. WB (11a)

Cast Aluminum as Domestic Material (Aluminiumguss als Heimwerkstoff). W. HARTL. *Automobiltechnische Zeitschrift*, Vol. 38, June 25, 1935, pages 301-307. The possibilities of replacing Cu containing materials by Al alloys are discussed. This material does not need to be imported in Germany. The most used alloys are:

German alloy	2% Cu	10% Zn	0% Si	88% Al
American alloy	8% Cu	0% Zn	0% Si	92% Al
Silumin	0% Cu	0% Zn	13% Si	87% Al

Another table gives the physical and mechanical properties of these castings. A number of castings are illustrated, and methods for cleaning them are described. Ha (11a)

Aluminum Alloys—The Influence of Manufacture on the Quality of Wrought Material. W. C. DEVEREUX. *Machinery*, London, Vol. 46, May 2, 1935, pages 140-142. Abstract of the 2nd part of paper before the Scottish local section of Institute of Metals. Ingots for forging or extruding must not be coarse grained or porous because the weak grain boundaries will allow coarse grain aggregates to work more easily and unduly stress the smaller grains causing cracking. The grain growth due to extended soaking is illustrated by photos. Precautions in the control of dummy shape and size and in the pressing operations are given. Curves are given of physical properties of various British, dural-type alloys which show the effect of heat treatment after cold-working. WB (11a)

11b. Ferrous

V. V. KENDALL, SECTION EDITOR

The Effect of Hydrogen on Cast Iron (Ueber den Einfluss von Wasserstoff auf Gusseisen). W. BAUKLOH. *Giesserei*, Vol. 22, Aug. 16, 1935, pages 406-409. The eventual possibilities of an attack by H on cast Fe and the permeability of cast Fe for H (due to its high diffusion capacity) were investigated. The decarburizing effect is based on the chemical reactions: (1) $C + 2H_2 = CH_4$, (2) $Fe_3C + 2H_2 = 3Fe + CH_4$ and increases with increasing pressure. Alloying elements to cast Fe change the magnitude of attack but do not suppress it. All additions, Si, Mn, Cr, Ni and Co, reduced decarburization considerably at the lower temperatures but quickly approached at higher temperatures the decarburization of the unalloyed material, except Cr and Co which always, and Ni and Mn which for more than about 3%, showed reduced decarburization. The rather complicated conditions are shown in curves for white and black cast Fe with various C contents. The permeability for H increases considerably with increasing C content, so that it seems that cast Fe is not particularly suitable for apparatus used in hydration plants; it can, however, be improved by alitizing. Cr prevents diffusion to a very large degree. It seems that after decarburization on the surface, further decarburization is possible only if H can diffuse through the newly formed solid solution of Fe and the respective alloying element into the interior. The practical aspects of this question for steel and cast Fe are discussed and further study is recommended. Ha (11b)

Temporal Changes of the Mechanical Properties of Newly-Rolled Rails, in Particular of Thomas Steel (Beitrag zur Kenntnis der zeitlichen Aenderungen der mechanischen Eigenschaften walzneuer Schienen, insbesondere aus Thomasstahl). F. KÖRBER & J. MEHOVAR. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf*, Vol. 17, No. 7, 1935, pages 89-105. It had been observed that the results of tensile tests on open-hearth steel rails varied considerably according to the time at which the tests were made, directly after rolling or some time later. A thorough investigation of this phenomenon with silicized Thomas rails of a tensile strength of 70-77 kg./mm.² with regard to eventual improvement of the properties and to the temporal progress in their changes showed that annealing of the prepared tensile specimens to 200°-600° C. causes an immediate recovery, that by storing the specimens the recovery requires days or months, and that by storing the whole rail the equilibrium of the tensile properties is reached only after several months. Open hearth steel rails were slower in reaching the best value than Thomas rails. The material undergoes an improvement as elongation and reduction of area are considerably increased whether the rails were straightened or not. The reason for these property changes is seen in the equalizing of internal stresses during annealing and storing, but in no way due to a precipitation. The testing methods are described in full. 22 references. Ha (11b)

The Question of Plasticity of Non-metallic Inclusions in Steel (Beitrag zur Frage der Plastizität nichtmetallischer Einschlüsse im Stahl). R. SCHNELL & E. SCHEIL. *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke Aktiengesellschaft, Dortmund*, Vol. 4, Dec. 1934, pages 235-246. In order to determine the deformability of slag inclusions in steel a series of upsetting tests was made at temperatures from 20° to 1260° C. with 6 different steels. Oxide inclusions were not plastic up to 900° C., above 1100° they began to follow the deformations of steel. The temperature of beginning deformation changes with different steels and seems to increase with the SiO_2 content of the inclusions. At low temperatures, the inclusions show a strong tendency to fracture under high deformation stresses while at higher temperatures they become plastic. Contrary to oxide inclusions, sulphide inclusions followed strictly the deformations of steel, even at as low a temperature as —80° C. The tests are reproduced in charts. 7 references. Ha (11b)

Investigation of Copper Steel at the Frunze Plant. G. ZAMORUEV. *Stal*, Vol. 4, Nov.-Dec. 1934, pages 58-70. In Russian. Open hearth Cu steel containing 0.15-1.23% Cu and 0.08-0.30% C can be rolled without difficulties and has good mechanical properties. In accelerated atmospheric corrosion tests, steel containing 0.35% Cu was found to be 1.5-1.7 times more resistant than ordinary steel. Further additions of Cu above 0.35% only slightly increased its resistance. In these tests heat treatment and variation in C content were found to have practically no effect on the corrosion resistance. Increasing the Mn content from 0.45 to 1.20% was found to decrease corrosion resistance 16%. Intermittent corrosion tests were also made in 3% NaCl solution. Although the results of these tests are as yet incomplete, they indicate that the stability of Cu steel in this solution varies greatly with the heat treatment. In 5% H_2SO_4 solution, steel containing 1% Cu was found to be 15 times more stable than steel without Cu. Tensile strength and elastic limit of 0.6-1.0% Cu steel can be considerably increased by drawing at 600°. Microscopic examination failed to reveal free Cu in any of these steels. HWR (11b)

Chromium-Molybdenum Steels as Substitution for Nickel-Chromium Steel. KASESHI BITO & SHIRO ISHIDA. *Tetsu-to-Hagane*, Vol. 21, May 25, 1935, pages 289-305. In Japanese. Tensile and impact strengths, fatigue limit and thermal expansion of Si-Mo-, Mn-Mo-, Si-Mn-Mo- and Cr-Mo- steels were measured and the lowering of Ar_{3-1} point was determined by means of a microscope and the Brinell hardness tester. 21 kinds of Cr-Mo-steel (1.2% Cr, 0.15-0.9% Mo, 0.24-0.45% C) which were quenched at 850°-860° and tempered at various temps. were subjected to the same tests. The following results were obtained: (1) The Mo-steel containing 0.35% C shows the best properties. (2) Mo is sufficient at 0.3-0.4%. (3) As a substitute for Ni-Cr-steel, the Cr-Mo-steel containing 0.33-0.35% C, 1.1-1.4% Cr, 0.3-0.4% Mo is recommended. (4) Ni, V, W, Cr, Al and Si do not improve the mechanical properties of the Cr-Mo steel while 1.5% Mn or 2% Ni somewhat improve the quenching effect of this steel. TS (11b)

U - Chromium Steels

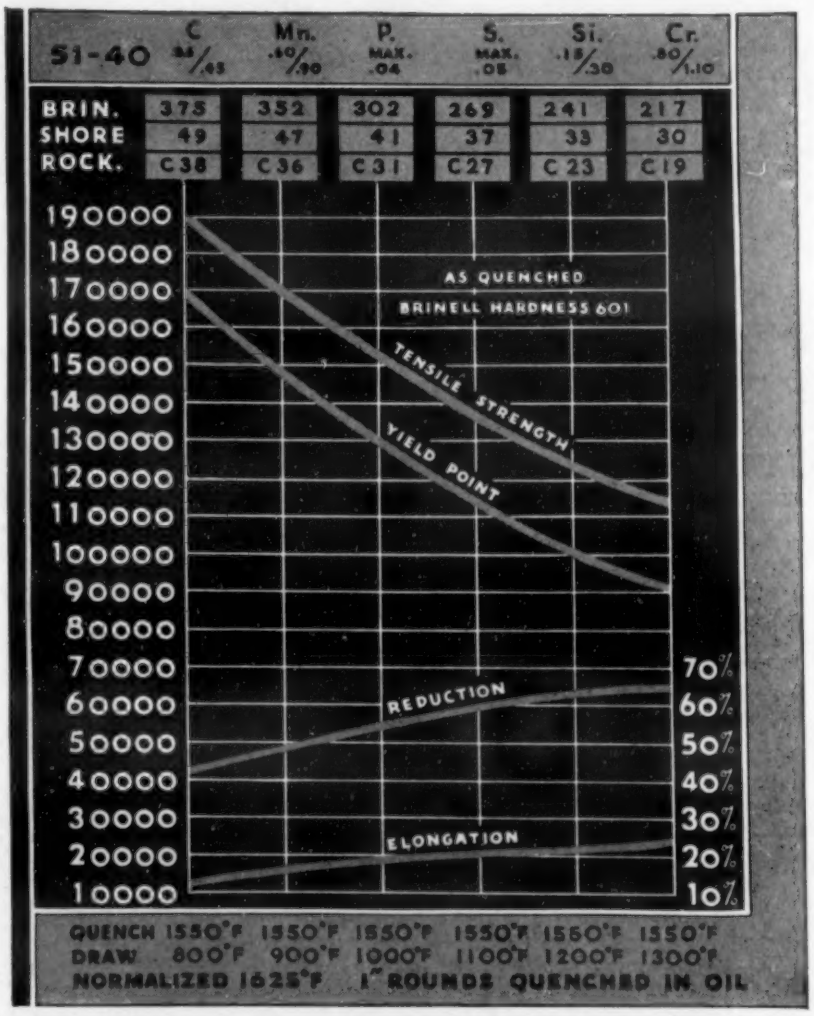
CHROMIUM as an alloy in steel is essentially a hardener and does not materially improve ductility. Steels with chromium as the only alloying element can carry a somewhat lower carbon content as compared to the chromium-free steels, resulting in a combination of high strength with satisfactory ductility.

The chromium alloy steels fall in the S. A. E. 5xxx Series. In the 51xx type the lower carbon carburizing grade carries 0.60 to 0.90 per cent chromium. Oil-hardening steels, which carry carbon in ranges of 0.35 to 0.45 and 0.45 to 0.55 per cent, have 0.80 to 1.10 per cent chromium. These steels are used for springs, gears, shear blades, studs, bolts and the usual industrial applications to which oil-hardening grades are suited.

The 52-100 grade is a special-purpose steel carrying 0.95 to 1.10 per cent carbon and 1.20 to 1.50 per cent chromium. The principal use of this steel is for balls, ball races, rollers and roller bearings.

Chromium steels other than those included in the S. A. E. classification often find definite and extensive application in industry.

Chromium steels have been used for magnets for a number of years. Where a low-strength magnet is satisfactory a steel carrying 0.55 to 0.65 per cent carbon and 0.70 to 1.00 per cent chromium finds a useful application. Where higher magnetic qualities are required, steels containing 2.00 to 2.50 and 3.50 to 4.00 per cent chromium, with about 1.00 per cent carbon, are used.



★ *Physical properties of S. A. E. 51-40, an oil-hardening chromium steel.* ★

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12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Experiments on the Tightness of Boiler Tubes at the Joint with Tube Plates (Versuche über die Haftfestigkeit von Heizrohren in Rohrplatten). ROBERT ENGEL. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 90, Mar. 15, 1935, pages 110-113. Experiments were made at the Technische Hochschule Graz on boiler tubes attached in 6 different fashions to Cu plates and submitted to a maximum of 24,500 heating cycles until leaking took place. The testing apparatus consisted of refractory muffles individually heated by an oil burner at one end and incorporating the Cu plate and boiler tube at the other end. The tube was enclosed in a water-cooled shell. Only the fuel was shut off at regular intervals while the compressed air continued to blow upon the tube joint to hasten its breakdown. The testing conditions were thus rendered more severe than under actual locomotive service conditions. Feeding cold water directly on the tube/plate joint shortened its life considerably. A specially designed joint incorporating a support ring in the joint proved to be very efficient. The tests also proved that the elimination or release of axial stresses at the rolled-in joint extended the life of the joint for a remarkable length of time even under extreme testing conditions. WH (12)

Thermal Expansion of Monocrystalline and Polycrystalline Antimony. PETER HIDNERT. *Bureau of Standards Journal of Research*, Vol. 14, May 1935, pages 523-544. Measurements were made on the linear thermal expansion of 11 samples of single crystals of Sb and 3 samples of polycrystalline Sb at various temperatures between 20° and 500° C., and these data were correlated with the results obtained by previous investigators to 300° C. The linear expansion depends upon the direction along which the measurements are made. The linear expansion along the trigonal axis (0° orientation) of a single crystal is about twice as large as the expansion along a direction perpendicular to this axis (90° orientation). Equations were derived which show the relationships between the coefficients of expansion and the orientations of single crystals. The linear thermal-expansion curves between 20° and 560° C. of polycrystalline Sb show that there is no polymorphic transition. The differences in the linear expansion of different samples of polycrystalline Sb are attributed to variations in the average orientation of the crystals. WAT (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

The Attack of Steel by Hydrogen and Hydrogen Sulphide Under High Pressure and at Elevated Temperature (Über den Angriff von Wasserstoff und Schwefelwasserstoff auf Stähle unter hohem Druck und bei erhöhter Temperatur). HERMANN VOLLBRECHT & EGBERT DITTRICH. *Chemische Fabrik*, Vol. 8, May 29, 1935, pages 193-196. Two steel tanks, .40% C, 3-4% Ni, .8-1.0% Cr, were held for 20,000 hours at 200 atmospheres and with the temperature varying from 200° to 300° C. at various points, one filled with H, the other with H and H_2S. The steel was then analyed at various depths for S and C and tensile tests were made on specimens cut axially and tangentially. The deterioration of the steel was due to H, not H_2S. The H penetrated entirely through the steel, removing C and causing porosity. H_2S penetrated into the surface only. The mixture of H and H_2S was slightly less harmful than H alone probably because FeS forms and fills in the porosity. The axial tensile tests were much higher than the tangential, showing the effect of stress on corrosion. CEM (13)

The Effect of Milk Upon Metals and Metals Upon Milk. BENJAMIN HATCH WHITFIELD, H. P. DAVIS & P. A. DOWNS. *Milk Dealer*, Vol. 24, Nov. 1934, pages 34-35, 78; Dec. 1934, pages 40-42; Jan. 1935, pages 42-44, 48. In a study of the corrosion of metals by milk and the effects of metals upon the flavor and quality of milk, the metals used were Ni, Cu, Al3S, Inconel and Allegheny metal. Metal strips were immersed in milk at 60° and 144° F. for ½, 2 and 4 hours, in the presence of air, O_2 and CO_2. Corrosion was measured by determining loss in weight. Only Cu and Ni were corroded; the loss in weight was in general greater in the latter. Of the 3 other metals, which were not corroded, none affected the flavor or color of milk. Under O_2, and at an exposure of 4 hours, Cu was corroded more than Ni. Corrosion was greater at the higher temperature. At 144°, the rates of corrosion of Cu and Ni were greater under O_2, less under air, and least under CO_2. At 60° the rate of corrosion of Cu was independent of the type of atmosphere; the corrosion of Ni was increased under CO_2. Weight loss/time curves tended to become horizontal as time increased. Rate of corrosion was increased when a large surface of milk per unit volume was exposed. Milk caused a brightening of Cu and a darkening of Ni; these effects were increased by O_2, time and temperature. Cu was detrimental to the flavor of milk; it caused a tallowy flavor to develop within 18 to 24 hrs. after exposure; the extent of the off-flavor varied with duration of time of exposure and time after exposure; it was increased by O_2 and decreased by CO_2. CO_2 caused an acid flavor in milk. Bacterial counts were not influenced by exposure of milk to metals. Cu tended to discolor milk more than did Ni; the greenish color caused by exposure at 144° was intensified by O_2 and by long exposure. 52 references. GPS (13)

Comparison of Pre-War and Post-War Steels as Regards Their Behavior in Water Heater and Heating Installations (Vergleich von Vorkriegs—und Nachkriegsstählen nach ihrem Verhalten in Warmwasser—und Heizungsanlagen). G. TICHY. *Paper Fourth Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker*, Nov. 20, 1934, Düsseldorf, pages 63-72. Includes discussion. Since users of such heating equipment were frequently complaining that prewar devices possessed a greater durability the author accumulated extensive data on such equipment and made laboratory tests. Steels made before and after the war were subjected to corrosion under conditions as they exist in water heating and room heating equipment. Considerable differences of corrosion behavior could not be found which confirmed American investigations stating that former steels are not distinguished by higher corrosion resistivity than our present ones. The cause of these complaints must be sought in change of construction, water conditions and operating conditions the effects of which on corrosion is overlooked. GN (13)

Corrosion in the Interior of Gas Pipes and Its Prevention (Korrosion im Inneren von Gasleitungen und deren Vermeidung). W. WUNSCH. *Paper Fourth Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker*, Nov. 20, 1934, Düsseldorf, pages 32-37. Includes discussion. Corrosion in the interior of gas pipes is less important than outside corrosion. It is less destructive but frequently causes plugging of the pipes since the corrosion products split off and are carried to narrow cross sections by the gas current. Elucidation of the occurrences of internal corrosion becomes difficult by formation of deposits that are not corrosion products. Rusting is caused by separation of H_2O when O is simultaneously present. Corrosion may be further caused by S compounds present in the gas, in particular by H_2S, HCN and NH_3. CO may also lead to corrosion. Internal corrosion cannot be prevented completely. Careful running of gas producers and cleaning equipment is the first remedy. Protective layers are used: for large pipes, asphalt; for smaller ones, Zn coating. An interesting failure in a gas main was reported in the discussion. In this gas pipe which contained welded sections, brittleness and cracks were observed due to the formation of strongly basic tar deposits. GN (13)

Effect of the Operating Conditions on the Behavior of Various Materials in Water Heaters (Einfluss der Betriebsbedingungen auf des Verhalten verschiedener Werkstoffe in Warmwasserbereitern). M. MENGERINGHAUSEN. *Paper Fourth Corrosion Congress Verein deutscher Eisenhüttenleute, Verein deutscher Ingenieure, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker*, Nov. 20, 1934, Düsseldorf, pages 38-47. Since corrosion increases with rising temperature, water heaters should not be operated at temperatures above 40°-45° C. High water pressure is also detrimental. Corrosion further increases with the time water is in contact with the heater material. Therefore, water capacity should not be too large. Effect of water circulation is not definitely known, however, uniform water current should be aimed at. In general the detrimental effect of various operating conditions cannot be completely eliminated. Chief remedies for avoiding corrosion are treatment of water, choice of corrosion resistant materials and suitable construction. GN (13)

Corrosion of Pipes in Soil and Protective Measures (Bodenkorrosion von Rohren und Schutzmassnahmen gegen sie). H. STEINRATH & H. KLAS. *Paper Fourth Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker,* Nov. 20, 1934, Düsseldorf, pages 9-21. Includes discussion. Every soil contains agents attacking the pipe metal, as chlorides, sulphates, nitrates, nitrites and ammonium salts. FeS is also detrimental due to possible formation of sulphates. Dependence of corrosion on H-ion concentration could not yet be clearly proven. However, corrosion increases with total acidity. Electric currents may also be important. Less corrodible metals cannot be used for this purpose due to high price and possible low strength. Therefore steel and cast Fe must be used. In general corrosion of common steel pipes is independent of steel composition. Protective measures such as metallic coatings, oil painting, layers processed by chromate and phosphate salts, tar and bituminous layers etc. were considered at length. The discussion in particular referred to the insulation of pipe joints. Whether insulation with hot bitumens or cold insulation with rapidly hardening bituminous coatings is more advisable cannot yet be definitely stated. In many cases jute and wool felt can be replaced by paper tissues. The importance of phosphate coatings was pointed out. GN (13)

Electrolytic Corrosion in Gas Mains. W. BECK. *Institution of Gas Engineers Communication* No. 69, May 1933, 48 pages. Laboratory experiments on measurement of electric currents in pipes exposed to attack by electrolysis are described. The application of the method to the detection of pipe defects is shown. Various new pipe coverings were exposed to the influence of electric current, low temperatures and vibration stress. Under static conditions an unprotected pipe became coated with a layer of sand impregnated with Fe salts. Acid-containing blisters developed on a pipe with a special chloro-vulcanite coating and the pipe became pitted. Rust spots and pittings followed the spiral line of asphalt-impregnated bandages. Similar data are given on other coatings. AHE (13)

Reducing Corrosion in Conductor Rails. *Transit Journal,* Vol. 79, July 1935, page 210. In the London subway system voltage drop in the conductor rails is reduced by having the joints electric welded. Corrosion in the open section of track is minimized by insistence on a very low S content of the rails. WHB (13)

Corrosion of Metals in Water and Aqueous Solutions (Die Korrosion der Metalle in Wasser und wässrigen Lösungen). C. CARIUS. *Paper Fourth Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker* Nov. 20, 1934, Düsseldorf, pages 1-8. Includes discussion. In contact with water every metal possesses a certain potential and the tendency to go into solution in form of ions. Gases also, for instance O, go into solution as ions. This tendency is very small with noble metals, increases with less noble metals such as Cu, Sn, Ni and is large with base metals as Fe, Zn, Mg. When the potential of the metal is less noble than that of O, the metal is charged by dissolved O and goes into solution as metal ion. By reaction of these metal ions with hydroxyl ions or other anions in the solution, insoluble compounds may be formed that are deposited on the surface and stop corrosion. Corrosion progresses when these protecting layers are interrupted or are attacked by CO_2 of water as is the case with Pb. A current then originates between the layers protected and unprotected. This becomes detrimental only when the current exceeds a certain amperage. This must be borne in mind in joining Fe with Cu, brass and other noble metals. The corrosion occurrences of Fe are complex since it may go into solution in 2 different valences. These different oxides formed possess differing protective action and corrosion may be accelerated with non-uniform distribution of layers. Furthermore it must be considered that H is formed when Fe corrodes. The discussion in particular referred to the importance of the corrosion deposits. GN (13)

Corrosion in Heating Equipment (Korrosion in Heizungsanlagen). W. BLUM. *Paper Fourth Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker,* Nov. 20, 1934, Düsseldorf, pages 61-62. Paper considers corrosion occurrences in steam heating installations in particular low pressure steam equipment. The methods of restriction or avoidance of this corrosion are not yet entirely satisfactory. The common methods of removing O and CO_2 in the boiler water are not successful with low pressure steam heaters. The installation of Mn steel wool containers was more satisfactory although corrosion could not be entirely avoided. GN (13)

Prevention of the Corrosion in Water Heaters by Constructional Measures (Vermeidung der Korrosion in Warmwasserbereitern durch bauliche Massnahmen). M. BRANDT. *Paper Fourth Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker,* Nov. 20, 1934, Düsseldorf, pages 48-54. Paper first refers to the constructional development of the 2 principal types of water heaters; heaters with storage tank which may be subdivided into high pressure and low pressure heaters and continuous heaters in which merely the amount of water to be used is heated. In continuous heaters corrosion is observed to a much smaller extent than in the first mentioned type. Corrosion in those heaters is traced to air bubbles that hardly have a possibility to adhere to the heater walls in continuous heaters, the water speed being too high. These bubbles can more easily escape in low pressure heaters than in high pressure heaters. It has actually been found that high pressure heaters are more rapidly destroyed than the low pressure type. The only successful means to avoid this occurrence in high pressure heaters is to design them accordingly. Protective coatings and paintings merely offer the advantage that a smooth wall is formed so that the bubbles cannot adhere to rough parts of the wall. Oblique arrangement of the heater is another remedy. Permanent supervision of heaters is finally advised. GN (13)

Heavy Coated Galvanized Sheets. GEO. C. BARTELLS. *Sheet Metal Worker,* Vol. 26, May 1935, pages 197-201. The use of the 2 oz. coated galvanized sheets instead of the lighter coatings (0.8 or 1.1 oz.) for corrugated and V-crimped roofing and siding is recommended as it gives longer life. Corrosion or rusting, "flaking," which sometimes sets in where tools have attacked the material in laying can be successfully avoided by immediately painting with a metallic Zn paint. Ha (13)

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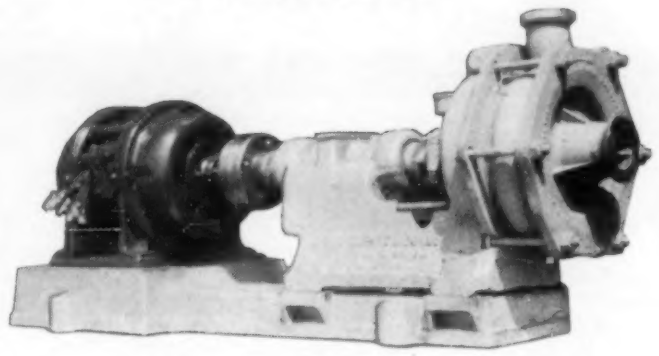

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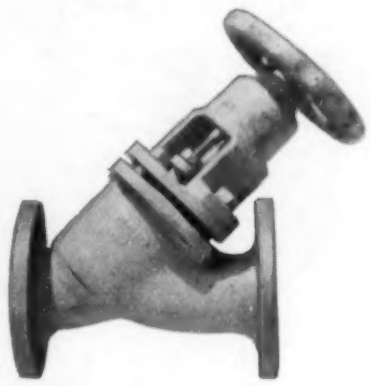

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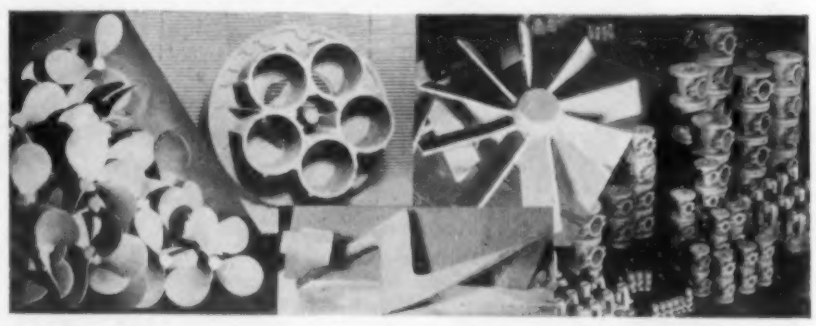

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14. APPLICATION OF METALS AND ALLOYS

Materials Used in Oil-refinery Pumps. A. E. HARNSBERGER. *Metals Technology*, Aug. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 631, 16 pages. Both ferrous and non-ferrous alloys used in pumps operating at different temperatures are discussed. Alloy steel and alloy iron parts are needed for many parts but the relatively high price of these materials limits their use. JLG (14)

Modern Alloys in Marine Engineering and Shipbuilding. J. W. DONALDSON. *Metal Treatment*, Vol. 1, Summer 1935, pages 59-62. Alloys used include guaranteed elastic limit (15 or 17-20%) steels and .2-.3% Cu steels for hull construction, modified 10-14% Si-Al alloys for hull fittings. Monel metal for kitchens, cabin fittings, and for lining trawler fish holds, Al brass and cupro-nickel for condenser tubes, Staybrite and A.T.V. steel for turbine blades, and high tensile brass with 2-3% Ni, Monel metal, and 3.5% Ni steel for propellers. JCC (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

The Production and Utilization of Thorium and Uranium. J. W. MARDEN. *Transactions Electrochemical Society*, Vol. 66, 1934, pages 39-47. 2 methods have been found to give a sufficiently pure and stable metal powder for sintering and working. The working properties of the 2 metals are discussed. Three principal uses found for these metals are described. The photoelectric properties of Th and U are used in measuring restricted portions of the ultraviolet spectrum. Th proved particularly useful in glow discharge tubes. Both metals have been used in X-ray tubes and under certain conditions may come to be of considerable commercial importance. (14a)

Materials for Screw Propeller. YOSHIRO FUJII. *Tetsu-to-Hagane*, Vol. 21, May 25, 1935, pages 305-314. Mechanical properties and corrosion fatigue limit of 2 kinds of Mn-bronze used for an actual screw propeller, (39% Zn, 1% Fe, 5.25% Mn and 39% Zn, 1% Fe, 5.62% Mn, 0.6% Al), were tested and it was made clear that the actual propellers are worked under the stress above the corrosion fatigue limit. 36 kinds of nonferrous alloys were subjected to the measurements of freezing points, single potentials in sea water and to the microscopical study beside the above mentioned tests. A new superior alloy for the screw propeller was found, its composition being 2-3% Al, 3-4% Ni, 1-2% Si, 22-25% Zn, and remainder Cu. The corrosion fatigue limit and resistance of corrosion by sea water of the new alloy were 3 and 2 times of those of the Mn-bronzes respectively. This alloy has good casting properties. TS (14a)

Low Melting-point Alloys. A. EYLES. *Machinery*, London, Vol. 46, June 13, 1935, pages 323-324. Comparisons are made between "Cerro-matrix" alloy, "Cerrobase" alloy and other low melting alloys. The Cerro alloys were developed by the Cerro de Pasco Copper Corp. for making air, oil and water-tight connections between metal and glass or porcelain, contour-backing blocks for hammering out dented metal, etc. WB (14a)

Telephone Lines Made of Aldrey (Linee Telefoniche in Aldrey). G. DASETTO. *Alluminio*, Vol. 4, May-June 1935, pages 149-155. Typical telephone line setups, using Aldrey are illustrated. Its mechanical properties are superior to Al, and only slightly inferior to Cu. AWC (14a)

Recent Investigations on the Properties of Thin Metallic Layers (Neuere Arbeiten über die Eigenschaften dünner Metallschichten). R. SCHULZE. *Die Metallbörse*, Vol. 25, Mar. 2, 1935, page 275. Lecture before the Physikalisches Colloquium Technische Hochschule Berlin. Differentiates between metallic layers and foil. The former represents a metallic deposit on glass or quartz. Electro deposition cathode atomization and direct evaporation and condensation on glass or SiO_2 yield very suitable thin metallic layer. Recently soluble carriers (NaCl) have been utilized in lieu of glass. Thickness of layer = 10 mμ. The speaker introduced a new method by first preparing a 100 mμ thick layer and then reducing it by cathodic atomization in vacuum to 2 mμ. C. Müller obtained strong Ni-layers of 10 mμ thickness by an electrolytic method. Physical testing methods for determination of the thickness of metallic layers are discussed. "Normal" metal layers are strong and behave in the same manner as the more compact metal. "Abnormal" layers probably possess no crystal lattice and their strength is almost 0. The physical properties of both types of layers are discussed. EF (14a)

Ferromagnetism of Platinum Chromium Alloys (Über den Ferromagnetismus der Platin-Chrom Legierungen). E. FRIEDRICH & A. KUSSMANN. *Physikalische Zeitschrift*, Vol. 36, Mar. 15, 1935, pages 185-192. The concentration range in which Cr-Pt alloys become ferromagnetic extends from 7-20 wt. % (22-48.5 at. %) Cr. On the Pt side, the Curie temperature reaches the absolute 0-point and vanishes in alloys higher in Cr at elevated temperatures (over 900° C.). The saturation magnetization curve exhibits a peak value at 10 wt. % (30 at. %) Cr. X-ray and microstructural investigations showed that at this concentration, a superstructure (probably $PtCr_3$) begins to appear and that it extends to high Cr contents. Contrary to our present knowledge, it is shown that the pure solid solution (at random distribution of atoms) as well as the structure with completely arranged atoms is paramagnetic and that ferromagnetism is only restricted to a transition range. Various possibilities of interpretation are discussed but no definite conclusions are warranted at present. It is not impossible that Pt as a metal of the 8th group in the periodic system might assume ferromagnetic properties under certain conditions. The ferromagnetic range of alloys exhibiting the Pt lattice and also other systems (for instance Pt-Co and Pt-Fe alloys) are highly indicative of this behavior of Pt. EF (14a)

Aluminum in Architecture (Aluminium im Bauwesen). E. HERMANN. *Aluminium*, Vol. 17, June 1935, pages 322-341. Numerous examples from many countries illustrate the extensive use now made of sheet or cast Al and Al alloys on the exterior of buildings, as statues, and for roofing. The different materials to be selected for best resistance against rain, polluted city air, or industrial districts are discussed. Ha (14a)

A New Alloy Specially Suitable for Use in Radium Beam Therapy. J. C. MCLENNAN & C. J. SMITHELLS. *Journal Scientific Instruments*, Vol. 12, May 1935, pages 159-160. A W-Ni-Cu alloy of density 16.5 is described, which has a mean absorption coefficient for hard γ rays of 0.83 $cm.^{-1}$ Details of method of preparing the alloy are given. RAW (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

Utilization of High Quality Material in Reinforced Concrete Construction. A Critical Study on the Safety and Admissible Stresses Based on New, Unpublished Experimental Results (Über die Verwendung hochwertiger Baustoffe im Eisenbetonbau. Eine kritische Studie über die Sicherheit und die zulässlichen Beanspruchungen auf Grund neuer, noch nicht veröffentlichter Versuchsergebnisse). PAUL ABELES. *Beton & Eisen*, Vol. 34, Apr. 20, 1935, pages 123-130; May 5, 1935, pages 139-146. Critically discusses the utilization of high-grade structural steels in reinforced concrete and the inadequate building specifications. Reports on extensive tests on reinforced structural members incorporating high-grade concrete as well as the German standard steels St 37 and St 55. WH (14b)

Cast Iron or Steel for Press Frames? S. D. BROOTZKOOS. *American Machinist*, Vol. 79, Aug. 28, 1935, pages 617-618. Both from the mechanical point of view and the cost for the structure, the modern special alloy cast irons are considered better than steel parts, welded or cast. Ha (14b)

Simplified Inlay Casting. HERBERT D. COY. *Journal American Dental Association*, Vol. 22, Mar. 1935, pages 434-438. Outlines a procedure for obtaining accurate castings and discusses the important factors in each step. OEH (14b)

Use of 12-14% Mn Steel Pins in Dredger Bucket Chains (Note sur l'Emploi des Axes d'Articulation en Acier au Mn 12-14% dans les Canines à Godets de Dragues). A. CAULLE. *Arts-et-Métiers*, Vol. 87, Aug. 1935, pages 166-175. Deals with breakages which often appear with 12-14% Mn steel pins. Failures are always very sudden and examination of fractures always shows cracks which may be a few mm. in length thus causing a reduction of useful section. Study concludes that breaks are due to slight bending of the pins during working of the dredge and that it is therefore necessary when mounting the dredge to set pins so that they cannot revolve. In no case is breakage to be imputed to poor quality or properties of steel. FR (14b)

Cast Iron for Vitreous Enamelling. J. W. GARDOM. *Foundry Trade Journal*, Vol. 52, June 13, 1935, pages 399-401, 403. Abstract of a paper read before the Institute of Vitreous Enamelers. Most irons for enamelling are of fairly thin section, and are classified by the foundryman as light castings. The chemical analysis of the Fe used can only be varied within fairly narrow limits, the range of the most important elements being as follows: T.C. 2.8-3.2; Si 2.0-3.0; Mn 0.4-0.8; P 1.0-1.5 and S < 0.15%. The P content of the metal is high for fluidity. No investigator had ever definitely said that there is a reaction between the graphite present in cast Fe and the enamel. Another important point is, does the C in solution at high temperature react with the enamel? If it could be proved that in cases where the graphite went into solution blistering occurred, this might explain why different investigators recommend widely-varying compositions for irons best suited for enamelling. The author feels that in cast Fe the absorption of gases is largely accumulation in the cavities between the graphite and the metal. That is why he recommended having the graphite in very fine flakes, so that the cavities would be smaller. These and other enamelling problems were discussed at length. AIK (14b)

Various Uses of Stainless Steel Coil Springs in Orthodontic Treatment. SAMUEL HERDER. *Dental Cosmos*, Vol. 77, Feb. 1935, pages 178-183. The author has used coiled springs made of hard-drawn stainless steel and considers them superior to Au-Pt in that stainless steel is "more elastic," does not discolor, and is lower in cost. Wires of .010" and .007" diameter are preferred for springs, and they are used both in compression and in tension. Heavier wire, such as .022" to .036" diameter, is used for arch wires. Predicts a more extensive use of stainless steel in orthodontia. OEH (14b)

Alloy Steels for Aircraft Construction. W. H. HATFIELD. *Metallurgia*, Vol. 12, June 1935, pages 45-48. Compositions and properties of different steels used in aircraft construction are given. The steels mentioned include C, alloy structural, stainless, valve and nitriding steels. JLG (14b)

Valve Design. R. JARDINE & R. S. JARDINE. *Automobile Engineer*, Vol. 25, Aug. 1935, pages 297-301. The best material to be used for valves in automobile engines is apparently an austenitic, sodium bath cooled steel; stellite valve seats, valve guides of non-growing material, e.g. Niresist. The design features which are important for long life are discussed. Ha (14b)

Containers of Light Steel for Gaseous Motor Fuels (Leichtstahlflaschen für gasförmige Treibstoffe). W. JAMM & K. WALTER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, June 22, 1935, pages 779-785. The highly compressed gases butane, propane, gas oil, used as motor fuels, must be stored only in seamless flasks for which a Cr-Mo-Ni steel in which the sum of the 3 alloying elements did not exceed 1.5% proved to be best. English steels admit up to 4.9%. The German flasks have a total length of 1590 mm., wall thickness of 4.6 mm., contain 43.5 l. and weigh 40.045 kg. They must stand a water pressure of 120 $kg./mm.^2$ (170,000 $lbs./in.^2$) which was obtained by proper heat treatment; elongation was 14%. Manufacturing processes and test methods and results are described. 11 references. Ha (14b)

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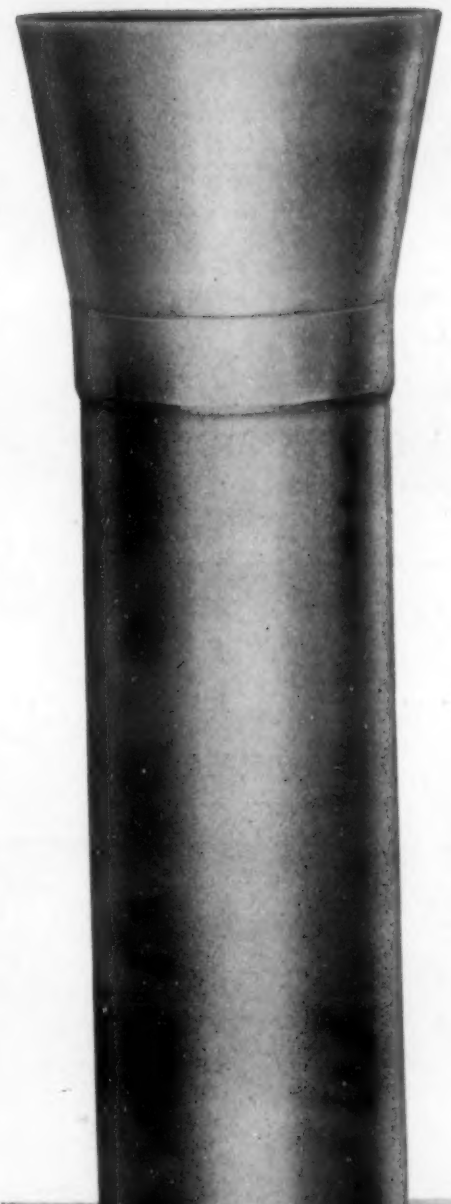

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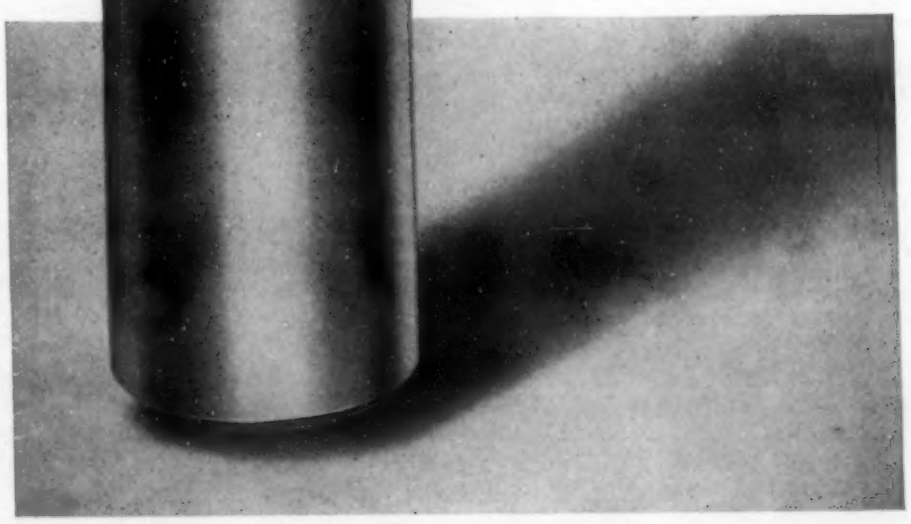

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15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

Mining Drill Steels. A. J. Beeley. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 11, Nov.-Dec. 1934, pages 352-355. General description of steel making. AHE (15)

Applications of Science to the Making and Finishing of Steel. John Johnston. *Mechanical Engineering*, Vol. 57, Feb. 1935, pages 79-86. A general review of the progress which was possible in producing modern steels in all their varieties due to application of scientific principles, especially of physical chemistry, to production processes. Ha (15)

Haber's Research on the Occurrence of Gold in the Ocean (Habers Forschungen über das Goldvorkommen im Meerwasser). Johannes Jaenicke. *Die Naturwissenschaften*, Vol. 23, Jan. 25, 1935, pages 57-63. One of Haber's former coworkers gives a full account of the extensive research aimed at the exploitation of the Au content present in seawater. This work resulted in a failure due to the previous untrustworthy statements concerning the percentage of Au in the ocean. It was finally established that there is only 1/1000 of the amount of Au present as claimed by former analyses. EF (15)

15a. Economic

The Future of Tin. *Tin*, July 1935, pages 1-2. Although at present Sn is mined from rich ores the future is considered questionable. Extraction and production activities and trend of production are discussed. A price 2 or 3 times as high as the present one is considered a very great probability. Ha (15a)

New Plant for Mechanical Constructions at Kramatorsk, South Russia (Les nouvelles usines de construction mécaniques de Kramatorsk, Russie Méridional). J. Vichniak. *Génie Civil*, Vol. 106, Jan. 26, 1935, pages 77-82. Description of a plant being constructed for supplying metallurgical equipment to the country. Most of the shops are not completed as yet. JDG (15a)

On the Presence of Rare Alkaline Metals in Amazonites. U. M. Tolmachev & A. N. Filippov. *Dokladui akademii nauk SSSR*, New Series, Vol. 3, Feb. 11, 1935, pages 321-323. In Russian. English translation on pages 323-325. Amazonites of 4 different origins were subjected to quantitative spectrographic analysis. Samples from the Il'menski Mountains (Ural) contained, on an average, 1% Rb, 0.05% Cs, 0.0015-0.002% Sr, less than 0.001% Li; those from Hibini (Russia) and Colorado (U.S.A.): 0.2% Rb, 0.005% Cs, less than 0.01% Li; those from Madagascar: 1% Rb, 0.15% Cs, 0.15% Li. ORS (15a)

German Tin (Deutches Zinn). P. Erimescu. *Die Metallbörse*, Vol. 25, Mar. 2, 1935, pages 273-274. Critical discussion on the possibilities of German deposits, ore dressing and metallurgical production. Data for the period of from 1920-1932 on the mining, metallurgical production and Sn-consumption in Germany are presented. Concludes that Germany can only produce 300 tons or 2% of its total consumption at the utmost, that the scrap metal market and the replacement of Sn-bearing alloys (bronzes, bearing metals, solders, etc.) offer some possibilities. EF (15a)

Iron Ores from the Imandrovskiy District of the Kola Peninsula and their Industrial Perspectives. A. Yu. Serk. *Gornuiy zhurnal*, Vol. 111 (New Series, Vol. 18), No. 1, Jan. 1935, pages 30-36. In Russian. Iron ore deposits discovered in 1932 on the Kola Peninsula (White Sea) and containing 30-40% Fe, about 45% SiO_2, are vast enough to permit a yearly production of 800,000 metric tons for 25 years of an agglomerate which is but slightly inferior to the Swedish Kiruna "A" iron ores. A project for their exploitation provides for their concentration and agglomeration at the mine and the shipment of the agglomerate to the Leningrad district for pig iron production with peat coke as fuel. The surplus agglomerate is to be exported. Detailed data on the location of deposits, the composition, concentration, and agglomeration of the ore, and the economical factors affecting the cost of the projected pig iron production are given. ORS (15a)

15b. Historical

Cast Pewter. Elsie Englefield. *Foundry Trade Journal*, Vol. 52, June 6, 1935, pages 379-381, 388. Abstract of a paper presented to the Worshipful Company of Pewterers. Early history of this trade, mold making and casting, soldering, etc. are discussed by the author. Ordinary good pewter is an alloy of Sn, Sb and Pb; a lower quality known in the trade as "black" is composed of 60% Sn and 40% Pb. A still lower grade is made up of 50% Sn and 50% Pb; the more Pb added the lower the quality and darker the appearance. Molds are the essential part of a pewterer's equipment. The molds are usually of gunmetal, very heavy and most carefully made. They are costly but last indefinitely. Englefield firm is still using some of the original molds dating back to 1700. AIK (15b)

The Evolution of the Plating Bath. H. J. T. Ellingham. Paper read before the *Electrodepositors' Technical Society*, May 15, 1935, pages 109-118. A short history of the progress of electroplating which started soon after Volta devised his battery in 1800. The first use of a cyanide solution was made about 1840 by John Wright, an English surgeon. By 1880 many of the methods in use became stabilized and little change occurred between then and 1911. From 1911 on scientific research began to exert an influence and the author portrays the resulting advance by giving a table of the elements which have been deposited from aqueous solutions. The latest of these are Re, Mo, W, and Nb. GBH (15b)

Man and Metal. William Larke. *Engineer*, Vol. 160, July 12, 1935, page 35. From the first "Edward Williams" lecture delivered before the Institute of British Foundrymen, Sheffield, July 1935. LFM (15b)

Current News Items

Acheson Medal Presented to F. J. Tone

It was an impressive event when the Edward Goodrich Acheson Medal was awarded to Dr. Frank J. Tone, president of the Carborundum Co., during the sixty-eighth general meeting of The Electrochemical Society at Washington, Oct. 10 to 12. The medal, established in 1928 by Dr. Acheson, is awarded periodically in recognition of outstanding achievements in electrothermics. The founder was the discoverer of silicon carbide or carborundum and also of amorphous graphite. He was awarded the first medal. The only two other recipients before Dr. Tone were Dr. E. F. Northrup, inventor of the Ajax high frequency electric furnace, and Dr. Colin G. Fink.

The presentation was made at the banquet which followed a reception to Dr. Tone. Dr. F. M. Becket of the Union Carbide & Carbon Corp., New York, delivered an excellent address on "The Scientific and Technical Accomplishments of Frank J. Tone," followed by "The Personal Side of the Medallist" by Dr. Carl G. Schluederberg, Westinghouse Electric & Mfg. Co., Cleveland. The medal was presented by the president of the Society, Dr. J. H. Critchett, vice president, Union Carbide & Carbon Research Laboratories, New York. The medal carries with it a prize of $1,000 which Dr. Tone turned back to the treasury of the Society.

After accepting the medal in behalf of himself and his co-workers, Dr. Tone delivered an address on "Super Refractories" which reviewed some of the achievements of the past and contained some decidedly interesting observations on future developments.

Additions to Battelle's Staff

Battelle Memorial Institute, Columbus, Ohio, has increased its technical staff in recent months to care for an expanding program of industrial research. New appointments include: Dr. W. C. Ashley, formerly with the Eastman Kodak Co., in the division of applied chemistry; Dr. C. F. Schmarje, formerly research assistant at Iowa State University, in the fuels division; M. L. Samuels, metallurgist, Tennessee Coal, Iron & Railroad Co., and J. G. Lowther, formerly research fellow at the University of Illinois, in the division of physical metallurgy.

Lloyd R. Jackson, formerly assistant research supervisor for the Jones & Laughlin Steel Co., with a wide experience in the manufacture of steel and steel products, has been assigned to the division of general metallurgy. Robert E. Parkinson, formerly with the Inland Steel Co., has also been assigned to the division of physical metallurgy.

The election of **John D. Swain** as vice-president of **Electro Metallurgical Sales Corp.** has been announced by J. M. Price, president. Mr. Swain has been vice president of The Linde Air Products Co. and Union Carbide Sales Co., which are other units of the Union Carbide & Carbon Corp. He has been actively connected with these units for a period of 20 years. His offices will be located in the Carbide and Carbon Building, 30 East 42nd Street, New York.

The Udylite Co., Detroit, announces the opening of a new warehouse in Chicago, especially for the convenience of the Udylite company's customers in the Chicago territory. The **Donald Sales & Mfg. Co.**, Milwaukee, has been appointed as distributor for Udylite's complete line of plating and polishing supplies, in Wisconsin.

For the most outstanding advertising campaign of the year in the field of metals, **Republic Steel Corp.** was awarded first prize by judges at the 13th Annual Conference of the National Industrial Advertisers Association held at Pittsburgh recently. S. A. Knisely, advertising and sales promotion manager of Republic, states that the prize-winning campaign was created and placed by **G. M. Basford Co.**, industrial advertising agency, with offices in New York and Pittsburgh.

Publishers of *Kinzoku*, the Japanese journal of metals, announce that the January, 1936, issue will contain special articles in English. The journal is published by The Agne Institute of Technology, Okamoto near Kobe, Japan.

McCune Receives Miller Medal

At the fall convention of the American Welding Society, in conjunction with the National Metal Congress at Chicago, the Samuel Wylie Miller Memorial Medal was presented to Charles A. McCune for his outstanding record in the field of welding.

Westinghouse Engineer Received Howe Medal

Trygve D. Yensen, engineer in charge of the magnetic division of the Westinghouse Electric & Mfg. Co.'s research department, received the Henry Marion Howe medal at the banquet of the American Society of Metals in the Palmer House, Oct 3. The other recipient was N. A. Zeigler, former associate of Dr. Yensen. The award is for joint authorship of a paper entitled "The Magnetic Properties of Iron as affected by Carbon, Oxygen and Grain Size," adjudged to be the best published in the Transactions of the American Society for Metals during 1934.

Bethlehem's Alloy Steel Catalog

The Bethlehem Steel Co., Bethlehem, Pa., has published a new catalog, "Bethlehem Alloy Steels." It is an attractive, 375-page, leather-bound book, containing numerous tables, charts and illustrations. It is decidedly comprehensive and may be placed in the same category as a hand book.

J. L. Wick, Jr. Chosen Vice President of A.F.A.

James L. Wick, Jr., president and general manager, Falcon Bronze Co., Youngstown, O., and a director of the American Foundrymen's Association, has been elected vice president of the association, to fill the vacancy occasioned by the death of Vice President B. H. Johnson. Mr. Wick has been active in the Association for many years, serving on committees and as a director.

Robert L. Baldwin is now sales development manager of the electrode division of **National Carbon Co., Inc.**, and is devoting his entire time to development problems. He brings to this work 25 years of close association with the electrode and electric furnace industries, a background which should be very helpful in enabling him to assist in working out problems of joint interest to electrode users, electrode makers and electric furnace marketers. After spending several years with the United States Steel Corp., engaged in the introduction and exploitation of the Heroult electric furnace, he was for 15 years sales manager of Republic Carbon Co., and recently sales manager of Republic Division of National Carbon Co. He will continue to maintain his office at Niagara Falls, N. Y.

Joseph T. Ryerson & Son, Inc., recently completed a new extensive addittion to their Jersey City plant, making available an additional 45,000 sq. ft. of floor space for the stocking of steel and allied lines.

The complete story of the production and use of the important industrial metal, nickel, is pictured interestingly in a new 2-reel, silent educational motion picture film, recently prepared under the supervision of the United States Bureau of Mines, Department of the Interior, in cooperation with an industrial concern.

R. L. Kenyon, supervising research engineer in charge of methods of physical testing and their development in the research laboratories of **The American Rolling Mill Co.**, Middletown, Ohio, has recently been placed in charge of all metallurgical work in the manufacture and development of wrought steel wheels.

To meet the increasing demand for Timken seamless tubing in the Chicago and Detroit areas, both offices have been expanded. David T. Marvel has been transferred from the Canton office of **The Timken Steel & Tube Co.** as sales representative and assistant to E. F. Talmadge in the Chicago office, 333 N. Michigan Ave., and C. Sidley Craine goes from Canton as sales representative and assistant to R. Atkinson in the Detroit Offce, Fisher Bldg.

MANUFACTURERS' LITERATURE

High Temperature Insulation

A colorful leaflet is devoted to insulating brick and insulating fire brick. A table showing chief characteristics of the different types is included. Armstrong Cork Products Co., Lancaster, Pa. (A 619)

Molybdenum in Iron and Steel

An attractive brochure contains a summary of the part played by molbydenum in ferrous progress, and claims that a great saving in cost with no impairment in quality can be obtained by its use. The Climax Molybdenum Co., New York, N. Y. (A 620)

Refractory Cement

Bulletin No. 317 describes Q-Chrome neutral-base refractory cement which was designed for severe-service duty. Quigley Company, Inc., New York, N. Y. (A 621)

Furnaces

This bulletin illustrates typical examples of this company's furnaces serving the oil industry. Mahr Mfg. Co., Minneapolis, Minn. (A 622)

Vanadium Facts

Another issue of this publication contains accounts of progress and performance in the field of alloy steels. Vanadium Corp. of America, New York, N. Y. (A 623)

Modern Gathmann Methods

A leaflet illustrates some of these methods and tells why they are vital to makers and users of steel. The Gathmann Engineering Co., Baltimore, Md. (A 624)

Steel Tubes

An illustrated leaflet devoted to the subject states that this company's tubing offers users an opportunity to improve their products and, in many cases, to reduce costs. Timken Steel and Tube Co., Canton, O. (A 625)

Phosphor Bronze

Booklet giving full information regarding this alloy, a true bronze of copper and tin with the addition of phosphorus, and, in the case of bearing metal, of lead as an antifriction ingredient. The Phosphor-Bronze Smelting Co., Philadelphia, Pa. (A 626)

Metallurgy of Wire Manufacture

This paper contains valuable and interesting data and was presented by H. W. Graham, general metallurgist of Jones & Laughlin Steel Corp., Pittsburgh, Pa. (A 627)

Special Atmospheres in the Heat Treatment and Brazing of Metals

A reprint of the above article by C. L. West, Research Engineer, is offered by The Electric Furnace Co., Salem, O. (A 628)

Brazing Alloy

Bulletin No. 5 advocates the use of "Sil-Fos" for joining brass, bronze, nickel, nickel silver, extruding brass and bronze, Monel metal and other nonferrous metals and alloy fusing above 1300 deg. F. Handy & Harman, New York, N. Y. (A 629)

Rolled Steel for Machine Construction

This attractive booklet contains valuable suggestions on the forms of steel available, short cuts to economy in buying, etc. Illinois Steel Co., Chicago, Ill., and Carnegie Steel Co., Pittsburgh, Pa. (A 630)

Industrial Application of the X-Ray

Bulletin 284 contains a complete treatise on the above subject. Notes on the selection of equipment. General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill. (A 631)

Binocular Microscope

Bulletin No. 9 illustrates a number of new constructions in wide field instruments with special reference to an automatic multiple objective nosepiece. E. Leitz, Inc., New York, N. Y. (A 632)

Better Castings

Interesting information is contained in this publication which is distributed by the Niagara Falls Smelting and Refining Corp., Buffalo, N. Y. (A 633)

Steam Drop Hammers

Bulletin 255 discusses the Chambersburg Model E Steam Drop Hammers. The advantages of the hammers, whose cylinders are made of Cecolloy, are listed. Chambersburg Engineering Co., Chambersburg, Penn. (A 634)

Chapmanizing

A pamphlet devoted to Chapmanizing, which is a process of hardening low-carbon steel, compares it to nitriding and carburizing. The Chapman Valve Mfg. Co., Indian Orchard, Mass. (A 635)

Metal Finishing

An attractively illustrated booklet discusses the importance of Grasselli electroplating chemicals and equipment and steel in the cleaning and finishing of metals. The Grasselli Chemical Co., Inc., Cleveland, O. (A 636)

The Jetal Process

Simple immersion in an aqueous bath for about 5 minutes colors all grades of common iron or steel a brilliant and uniform jet black. It is claimed it does not alter dimensions of articles and cannot chip, scale, peel or discolor. Alrose Chemical Co., Providence, R. I. (A 637)

Aluminum Alloy Castings

An attractive booklet contains interesting information on selection, mixing, melting practice, molding practice for sand castings, heat treatment, etc. of these alloys. Arthur Seligman & Co., Inc., New York, N. Y. (A 638)

Hold-Heet Pyrometers

Wall type and Lance type are described and illustrated in Bulletin No. 202. Russell Electric Co., Chicago, Ill. (A 639)

K & S Pyrometer

Leaflet illustrating and describing this pyrometer whose manufacturers claim it is the most compact, accurate, lowest priced and simplest to use. Industrial Pyrometer Co., Painesville, O. (A 640)

Torsion Impact Testing Machine

Bulletin No. 114 discusses the Carpenter machine whose operation is very simple and requires only one operator. Some test data are included in order to make comparisons between the torsion impact method and the usual impact methods. Baldwin-Southwark Corp., Philadelphia, Pa. (A 641)

Alloy Still Tubes

High temperature creep values of these low priced tubes are the subject of this leaflet which supersedes Circular Letter No. 2A, dated Nov. 1, 1933. The Calorizing Company, Pittsburgh, Pa. (A 642)

A New Inhibitor

Ferritrol No. 100 is offered as the most nearly perfect inhibitor which synthetic chemistry can produce in a leaflet of E. F. Houghton & Co., Philadelphia, Pa. (A 643)

Light Weight Insulating Brick

Therm-O-Flake brick which has low thermal conductivity and is recommended for cushioning furnace binding against expanding brickwork is the subject of a leaflet distributed by the Illinois Clay Products Co., Joliet, Ill. (A 644)

Modern Metal Treatment

A colorful pamphlet lists the R & H chemicals available for heat-treating, electroplating and for cleaning metals. E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (A 645)

Welding Rod

A booklet telling about their Roman Bronze welding rod, and illustrating some of its uses has been issued by the Revere Copper and Brass, Inc., New York, N. Y. (A 646)

Stainless and Heat Resisting Electrodes

A colorful price list and data book containing complete descriptions of the company's products and also analyses of stainless and heat resisting alloys manufactured by other companies has been issued by Maurath, Inc., Cleveland, O. (A 647)

Alumite Plast-O-Fractory

Bulletin 26, Series A, contains directions for using and recommended applications for this refractory material in plastic, moldable form. Illustrated. The Massillon Refractories Co., Massillon, Ohio. (A 648)

Potentiometer Controllers

Bulletin No. 202 covers the complete line of potentiometer and resistance thermometer controllers. A number of simplified wiring diagrams showing how an installation looks are included. Foxboro Company, Foxboro, Mass. (A 704)

Gas Fired Oven Furnace

A looseleaf page is devoted to this furnace designed for batch treatment of ceramic products uninjured by contact with products of combustion and for carburizing, tempering, annealing and heat treating metals. The Philadelphia Drying Machinery Co., Philadelphia, Pa. (A 705)

Electrode for Welding Cast Iron

This leaflet discusses "Ferroweld" which has a steel core surrounded by a heavy flux coating providing a shielded arc. Lincoln Electric Co., Cleveland, O. (A 706)

Barrett Fusion Furnace

This furnace which was designed especially for coal ash fusions, and other high temperature work up to 3000 deg. F. is described and illustrated in a bulletin of the Burrell Technical Supply Co., Pittsburgh, Pa. (A 707)

Machine Gas Cutting

An attractive and well-illustrated booklet tells how this has been made practicable, from both operating and economic standpoints, by the development of the Airco-D-B Camograph. Air Reduction Sales Co., New York, N. Y. (A 708)

Properties of OFHC Copper

An attractive booklet contains reprints of three papers relating to the above subject. Photographs, diagrams and photomicrographs are used to illustrate them. United States Metals Refining Co., New York, N. Y. (A 709)

Aerocase

Booklet on this subject. Illustrations, curve charts, tables. American Cyanamid and Chemical Corp., New York, N. Y. (A 710)

Centrifugal Compressors

Bulletin 386 is devoted to this company's Design 9 Compressors. Illustrated. B. F. Sturtevant Co., Boston, Mass. (A 711)

Dolomite Refractories

This interesting pamphlet presents the case of Clinkered vs. Calcined Dolomite in the basic open-hearth steel furnace. Basic Dolomite, Inc., Cleveland, O. (A 712)

"Nothing is Impossible to Industry"

Leaflet descriptive of complete units for oil or gas using special composition cast pots. The Campbell-Hausfeld Co., Harrison, O. (A 713)

Refractory Cement

A leaflet pictures the results of a test performed on five brands of refractory cement which were trowelled on a tile and fired at 2700 deg. F. Charles Taylor Sons Company, Cincinnati, O. (A 714)

Air Operated Controllers

Catalog No. 8900 gives information on a complete line of these controllers for temperature, flow pressure and liquid level which, according to the manufacturer, meet rigid requirements for accuracy, simplicity, flexibility and adaptability. The Brown Instrument Company, Philadelphia, Pa. (A 715)

Sintered Carbides

This new booklet contains quite complete information on Firthite cutting tools which, the manufacturer claims, increase and better production and reduce tool cost. Firth-Sterling Steel Company, McKeesport, Pa. (A 716)

The Stainless Prince of Steels

The uses of stainless steel "forerunner of a new era in metallurgy" are discussed and beautifully illustrated in a booklet published by The Chemical Foundation, Inc., New York, N. Y. (A 717)

Colmonoy

Bulletin No. 40 describes this new wear-resistant, corrosion-resistant, heat-resistant overlay metal and its products. Colmonoy, Inc., Los Nietos, Cal. (A 718)

Control of Chromium Plating Solutions

Analytical sets are described and illustrated in a leaflet of the Kocour Co., Chicago, Ill. (A 719)

Nickel Manganese Steel Welding Rod

Bulletin No. 10 is devoted to the above, which was developed for use on castings of standard manganese steel. Suggestions for welding with this rod are included. American Manganese Steel Company, Chicago Heights, Ill. (A 720)

Maintenance Bearings and Bronzes

Johnson machined bars and general purpose bushings for all industry are the subjects of an illustrated leaflet. Johnson Bronze Company, New Castle, Pa. (A 721)

Some Notes on Bethlehem Alloy Steels

Booklet No. 88 describes manganese, nickel, chromium, nickel-chrome, molybdenum, chrome-vanadium and silico manganese steels and includes a physical property chart for each group. Bethlehem Steel Company, Bethlehem, Pa. (A 722)

Metalgram No. 1

Contains charts of physical properties of a zinc base die cast alloy, taking into consideration the variation in properties due to metal and die temperatures and pressures. Apex Smelting Co., Chicago, Ill. (A 723)

Diesel Engine Pyrometer

This pyrometer, and indicating selector switch, both of which are dust, moisture and fume proof and mounted on a common base, are described and illustrated in a leaflet of the Thermo Control Devices, Inc., Chicago, Ill. (A 724)

X-Ray and the Foundry

Interesting treatise on this subject setting forth how the X-Ray has now come to the fore as a tool of the testing laboratory. Kelley-Koett Mfg. Co., Inc., Covington, Ky. (A 725)

Temperature Measuring Instruments

Descriptions of the more popular types of "Alnor" instruments which, it is stated, pay for themselves in the saving of fuel, reduction of scrap losses and improved products, are contained in a folder of the Illinois Testing Laboratories, Inc., Chicago, Ill. (A 726)

High Temperature Resistance Alloys

Kanthal alloys, made of chromium, aluminum, cobalt and iron, in three grades for different temperatures, are discussed in a leaflet offered by The C. O. Jelliff Mfg. Corp., Southport, Conn. (A 727)

Airless Wheelabrator

Circular descriptive of an entirely new method of abrasive cleaning. American Foundry Equipment Co., Mishawaka, Ind. (A 728)

Zinc Alloy Die Castings

A photographic review of die casting progress is offered in a profusely illustrated booklet, "A Visual Report of Progress." The New Jersey Zinc Company, New York, N. Y. (A 729)

Magnesium Alloys

Punched Data Sheets, complete with tables and diagrams, have been issued by this company under date of May 28, 1935. These sheets supersede all previous data. Subjects covered include physical characteristics, composition of alloys, sand castings, die castings, etc. American Magnesium Corp., Cleveland, Ohio. (A 730)

Combustion Control

Type MC for steam boilers maintains a uniform steam pressure and a correct flow of air for all rates of fuel supply according to the manufacturers. It is also adaptable to any kind of fuel, any make, type or size of boiler and to any number of boilers in a battery. Information on construction and operation are included. Diagrams. Shallcross Controls, Inc., Milwaukee, Wis. (A 731)

Rotoblast

A new bulletin from this company describes subject which eliminates compressed air in blast-cleaning. It is claimed that total cleaning time is cut to a level never before possible. Pangborn Corp., Hagerstown, Md. (A 732)

Suspended Wall Construction

The CHICO ABC wall permits use of either insulating or standard refractories and is adaptable to the specific requirements of almost any furnace, large or small, according to the manufacturer. A typical installation is illustrated. Chicago Fire Brick Co., Chicago, Ill. (A 733)

Mo-Max

This high-speed molybdenum-tungsten steel for cutting tools is the subject of a leaflet of The Cleveland Twist Drill Co., Cleveland, O. (A 734).

Dr. Saklatwalla's New Organization

The U. S. Rustless Steel & Iron Corp. is the name of the new organization which Dr. B. D. Saklatwalla has formed since his resignation as vice-president from the Vanadium Corp. of America. Dr. Saklatwalla is president of the new company which has headquarters in the Gulf Building, Pittsburgh. The new company is described as an industrial development organization which, besides serving the metallurgical and chemical industries in a consulting and advisory capacity, will undertake development and exploitation of new steels, alloys, and other technical products for specific requirements. It will particularly specialize in handling transfer of new engineering developments, processes and products among the various industrial countries of the world, with suitable foreign connections.

The **Lebanon Steel Foundry**, Lebanon, Pa., takes pleasure in announcing the appointment of **Peter A. Frasse & Co., Inc.**, as sales representatives for its corrosion, stainless, and heat-resistant alloy cast products. Having offices in New York, Philadelphia, Buffalo, Hartford, Rochester and Syracuse, the Frasse company will represent Lebanon in the States of New York, Connecticut, New Jersey, Delaware, Maryland, Virginia, and Pennsylvania east of Altoona. By adding Lebanon's corrosion and heat-resistant alloy castings to its stainless sheets, bars, and tube products, the "House of Frasse" establishes a complete stainless service for its trade along the most economical lines. "By availing ourselves of Frasse's almost century-and-a-quarter of useful service in the metal industries, it makes possible our more actively and efficiently meeting the growing demand for corrosion and heat-resistant castings which Lebanon produces under the most approved plan of metallurgical control, and with plant facilities incorporating both induction and arc type melting practices."

At the last meeting of the board of directors of the **Summerill Tubing Co.**, Bridgeport, Pa., the following officers were elected: E. L. Parker continues as president, which position he also holds with the Columbia Steel & Shafting Co. and its subsidiary, the Edgar T. Ward's Sons Co., Pittsburgh. J. P. Boore, who has been acting as assistant to the president for the past two years, was elected vice-president and is moving from Pittsburgh to Bridgeport to devote all of his time to Summerill. George P. Kraemer was elected secretary and treasurer. He will continue his connection as assistant manager of the Philadelphia branch of Edgar T. Ward's Sons Co. and devote a part of his time to the Summerill interests. N. H. Wolf, located at Bridgeport, continues as general manager, which position he has occupied for many years. H. M. Brightman, located at Pittsburgh, will continue as assistant to the president, and devote most of his time to research and other engineering problems.

Wilbur B. Driver Co., Newark, N. J., manufacturers of "Tophet," "Cupron" and other resistance alloys, announces that Erich Fetz has joined its metallurgical staff as research metallurgist. Mr. Fetz has had extended metallurgical experience in this country and abroad.

The board of directors of **A. O. Smith Corp.**, through Rae F. Bell, executive vice president, have announced the election of **Carl C. Joys, Jr.**, to the office of vice president of the corporation. Mr. Joys has been connected with the Smith corporation since Aug. 1, 1924, as manager of sales, and later in the capacity of director of sales of the oil and gas products division and all other products from the automotive division and has devoted his entire time to these lines. He will continue this work in his new position as vice president. Mr. Joys has been a director of the corporation since October, 1927.

Aluminum Industries, Inc., Cincinnati, manufacturers of "Permite" products, has announced the opening, on Sept. 3, of a new office, In Suite 1004, Petroleum Building, 616 S. Michigan Ave., Chicago. The office will be the headquarters of "Permite" sales representatives and sales engineers servicing the central states. The same announcement notes the acquisition of **R. L. Corey**, long connected with the automotive and industrial trade, as district sales representative for Indiana, Illinois, Wisconsin, Iowa, Missouri and Minnesota. **N. R. Patterson**, for the last year affiliated with "Permite," as sales engineer, also will have his headquarters in the Chicago office.

Large Electric Heat-Treating Furnaces for Ford

Thirteen big bell-type electric furnaces, larger than any of this type heretofore constructed, will soon be installed by the General Electric Co., in the Rouge Plant of the Ford Motor Co., where, in conjunction with 12 other bell-type furnaces built by another manufacturer, they will be used to anneal steel strip for the Ford V-8. Each is of sufficient capacity to bright-anneal, in one charge, two 16,000-lb. coils of steel strip 48 in. wide, 52 in. outside diameter and 30 in. inside diameter. They are of the controlled atmosphere type.

Another Stainless Steel Train

The "Mark Twain," a 4-car, light-weight, stainless steel train, built by the Edward G. Budd Mfg. Co., Philadelphia, has been added to the fleet of stream-lined, diesel-powered trains of the Burlington Railroad. It will replace two steam trains between St. Louis, Mo., and Burlington, Iowa.

The Burlington already has in operation the original Zephyr which has covered approximately 200,000 miles since it was placed in regular service between Lincoln, Omaha and Kansas City on Nov. 11, 1934, and the Zephyr Twins, placed in service last April, each of which is making a daily round trip between Chicago and the Twin Cities. The first Zephyr, originally a three-car train, was increased to four cars to accommodate the passenger demand.

World's Smallest Power Shovel

A midget power shovel made the dirt fly when ground was broken for the new Employees' Welfare Building of the Harnischfeger Corp. at Milwaukee, a celebration which was attended by nearly 1,000 of the company's workers, executives and guests. The tiny machine is an exact half-size duplicate of the new P & H Bantam Weight, recently introduced, and is said to be the smallest power excavator in the world. It has a capacity of 3/16-yd and is powered by electricity. It served as a working model in the designing and building of the first Model 100 machines which are ⅜-yd. capacity.

The **Timken Steel & Tube Co.**, Canton, Ohio, announces the opening of a new office at 16 West 60th St., New York City, to better serve the metropolitan area trade in seamless tubing and alloy steel of all types. **Arthur R. Adelberg** has been appointed district manager of sales in charge of the new office.

On July 30, 1935, **the Carborundum Co.**, Niagara Falls, N. Y., purchased the personal assets and good-will of the Hutto Engineering Co., Inc. of Detroit, pioneer manufacturer of cylinder honing and grinding tools and machines. Hutto products are generally used throughout the world in the manufacture of motor cars, Diesel engines, air compressors and similar equipment where extreme accuracy and finish are required. The operations of the Hutto company will be continued and expanded as a new division of the Carborundum company to be known as the Hutto Machine Division of the Carborundum Co., and will be carried on in the present modern plant located at 515 Lycaste Ave., Detroit. The present management is being continued. Joseph A. Carlin has been appointed manager and John E. Kline chief engineer of this new division.

The **American Electric Furnace Co.**, Boston, announces the following appointment of direct factory representative for the sales and service of all products of the company: Carman Adams, Inc., 2970 West Grand Boulevard, Detroit, for the state of Michigan.

Fisher Scientific Co., Pittsburgh, has been appointed exclusive sales representative for Zeiss metallographical equipment and accessories in the Pittsburgh and Cleveland districts. Complete equipment is on display at the Pittsburgh headquarters of the Fisher company.

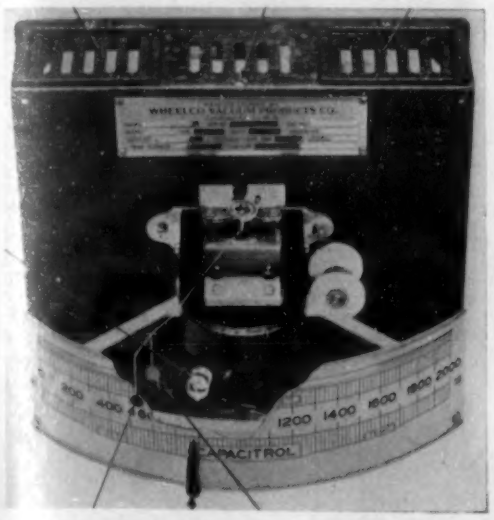
Walter S. Alysworth, Pittsburgh representative for **The Chas. Taylor Sons Co.**, manufacturers of "P. B. Sillimanite" Taylor refractory insulating brick, "Tiger Steel" brand fireclay brick and refractory specialties, announces removal to larger quarters, located in the Martin Building, Pittsburgh. Charles C. Carmody, formerly with Frederick, Traugott, Allen & Co., has become associated with Mr. Aylsworth in the sale of these products.

New Equipment and Materials

Simplified Temperature Control

A new method of temperature control has been devised which is known as the Wheelco System of Automatic Temperature Control. Unlike other systems or methods used in pyrometric indicating, recording or control devices, the pointer of the galvanometer has no mechanical work to do to cause the relay to function.

This fundamental feature and its successful accomplishment by the "Wheelco" method affords a simplified control means, obviating the use of mechanical contrivances such as gears, motors, depressor bars, springs, cams, etc. In other words, it performs electrically, with the use of a vacuum tube. By the very nature of the no contact system employed, accuracy of control—that is the translation of mechanical motion on the scale to electrical function of the contactor—may, by a permanent adjustment, be made as broad as the scale or as narrow as is required. Obviously, it would appear in such an accomplishment that a system of control is presented which is very much



simpler in operation, more economical in construction with less instrumentation to present the possibilities of getting out of order.

Instruments made under the "Wheelco" method were exhibited publicly for the first time at the recent Metal Show in Chicago, by the Thermo Control Devices, Inc., 1112-1114 Milwaukee Ave., Chicago, exclusive distributors. While this company claims to construct and offer its indicating and control instruments on a much more economical basis because of their simplicity, stress is not laid upon the price feature. According to Dr. Theodore A. Cohen, vice-president and engineer in charge of operations of this company, any control device must justify itself by its dependability and thoroughly efficient service rendered and not upon price alone; in the Wheelco simplified no contact control system, this dependability of constant, continuous operation is present, and with its fewer parts involved, obviously there is less service and maintenance cost required.

Among the devices which this company now offers is a Temperature Limit Control called the "Wheelco Limitrol," designed to operate with any present auxiliary or relay means of control in use. It can be adapted to indicate the temperature within any range between zero and 3000 deg. F. An indicator is set at the limit of temperature desired. When the temperature in the oven or furnace reaches this limit, the Limitrol will signal a warning by light or bell (both if desired) and shut off the furnace or oven.

The "Wheelco Limitrol" is also furnished with an automatic switch that will handle up to 39 thermocouples. With this type of Limitrol the temperature at one thermocouple is indicated every 10 seconds. When the limit of temperature is reached at any thermocouple, the Limitrol will automatically deliver its signal, indicate the number of the thermocouple located in the furnace or at point where the trouble exists, stop the switch, and may also be arranged to shut off the furnace. When this happens, it is simply necessary to press a button on the front of the instrument to set it into immediate operation again, and to give the necessary attention to the furnace or point indicated.

It is believed that this system as applied to control will find its practical and profitable use in many processes where it is essential to maintain temperatures within a narrow or restricted range, and where the danger of injury to batch or furnace might accrue with excess temperature.

New "Tag No. 40" Controller

A new instrument to be known as the "Tag Number 40 Controller," ideally suited to the majority of automatic control applications, has been recently put on the market by the C. J. Tagliabue Mfg. Co. of Brooklyn. The principle of control is basically the "Tag" movement which has served industry so successfully for many years. It has been redesigned for compactness in such a fashion that the few simple parts are accessible with exceptional ease. Tube systems can be interchanged with surprising facility.

A novel spring lever designed to eliminate all lost motion multiplies the movement of the powerful capsular spring for sensitive yet positive control. The smallest change in temperature is transmitted positively and with great precision to the Tag ball air valve which in turn resets the rate-of-flow through the diaphragm actuated control valve. In the Tag Number 40 Controller the sensitiveness is claimed to be high and the accuracy is permanent.

Indicating and Non-Indicating types in nine convenient temperature ranges and three pressure ranges are available in this new controller. The company has prepared an interesting bulletin giving complete details of operation, specifications and prices.

Salts and Solutions for Plating Pd and Au

Pre-Metals, Inc., Utica, N. Y., has been organized to manufacture salts and solutions for plating palladium and gold. They will also engage in trading in precious metals and ores of all types. Harrison S. Sweet is president; Leo J. Oster, treasurer; Daniel Wetzel, secy.; Mitchell I. Liebenson, vice-president and general manager. The works and laboratories are in Utica, under the control of Daniel Gray, chief chemist. A New York office has been located at 120 Wall St. with Mr. Liebenson in charge. The company is interested in buying precious metals and ores in all forms.

Centrifugally Cast Heat Resistant Rolls

An example of the contribution made to steel production by the advance in heat-resistant alloy castings is the rolls used in normalizing furnaces recently completed by the Michiana Products Corp., Michigan City, Ind. These rolls are of special heat-resistant alloy. They are cast on a newly completed centrifugal casting machine designed by Michiana metallurgists. The Michiana centrifugal casting method produces rolls of superior surface, a surface meeting the need for

a roll surface which will not scar a steel sheet. The strength and serviceability of the rolls are also increased by this method of casting since uniform structure through and through is assured.

A new patented method is used to attach the trunnions to the barrel. They are cast funnel-shaped at the joining end, that end being of a diameter to fit closely inside the roll which is hollow. The ends of the roll are slit for swaging over the end of the trunnion. After swaging, the segments of the roll are electric welded together and to the trunnion, making an exceptionally strong and rigid construction.

Improved Insulating Refractory Concrete

An hydraulic insulating refractory concrete known as "Insulcrete" that takes the place of firebrick and insulation combined for poured refractory furnace lining, doors, floors, covers, car tops, special shapes, etc. has been developed by the Quigley Co., Inc., 56 West 45th St., New York. This new development is said to possess the unique properties of interlocking crystalline minerals which form a light weight cellular insulating-refractory concrete.

Insulcrete is claimed to be more rugged, lighter in weight and more refractory than ever. No cutting and no fitting is necessary. It is just poured into place. The outstanding characteristics are said to be:

(1) Low heat storage—less than one-half that of fire brick; (2) heat resistance to furnace temperature up to 2500 deg. F.; (3) low permeability compared with other insulating refractory castables; (4) negligible shrinkage or expansion from casting to working temperatures; (5) air sets ready for use in from 12 to 24 hrs.; (6) high load carrying capacity; (7) highly resistant to thermal shocks; (8) weight approximately 60 lb. per cu. ft.

Insulcrete at a mean temperature of 1100 deg. F. has a thermal conductivity of 3.13 B.t.u. per sq. ft. per inch thickness, per deg. F. per hr., compared with first quality fire brick which at same temperature is 8.16. It is a 62¼ per cent better insulator and has less than half the heat storage of firebrick, which makes it both a fuel and time saver.

A special feature is low cost of installation.

New Thermometer Principle Uses "Coils Within Coils"

A new principle of thermometer construction, which is said to remove many previous limitations to the accuracy and durability of temperature indicating and control devices, has recently been developed in Europe and will soon be introduced into this country. Making use of bi-metal strip, which deflects in proportion to temperature change, the principle involves a unique method of winding the strip into a unit of concentric helical coils so that the forces of deflection are additive, but the forces tending to cause distortion and friction are mutually counterbalanced within the coils.

Using the new form of coil, it is possible for the first time to construct rugged, all-metal thermometers with an accuracy equal to or exceeding that of the ordinary spirit of mercury type, according to tests made in the laboratories of the German College of Science and Technology, Prague. Tiny thermal elements, less than ¼ in. in length, or large elements with sufficient torque to move a pointer 6 ft. or more in length can be constructed with the same general form of coil. Deflection sufficient to space out a narrow temperature range over a 360-deg. circular scale is said to be obtained without loss of accuracy.

The new form of coil was first proposed as a result of mathematical analysis by Franz G. Bloch, several years ago. Because the degree to which bi-metal strip bends when subjected to a slight temperature change

is so small in proportion to its length, the strip is usually wound in the form of a spiral or helix to provide sufficient length to operate a pointer over a legible scale. Bloch found however, that both spirals and helices lack the necessary rigidity to give a true angular deflection when the coil weight and the necessary turning force are considered. Moreover, increasing the thickness or width of the strip to give the rigidity required decreases the deflection and leads to distortion because of cross-bending across the width of the strip.

A coil consisting of concentric helices—in reality, "coils within coils" in which all the forces except that which causes angular deflection are mutually counterbalanced—was found to offer a mathematically balanced unit which was both more rigid and more compact. In most applications, the unit requires no supporting bearing at the working end. Even when a bearing is desirable, there is no tendency for a shift in the axis of rotation, which ordinarily leads to varying frictional resistance at this point.

Having developed the ideal form of coil by mathematical analysis, Bloch then discovered that there was no equipment in existence on which such coils could be wound. Consequently a new type of coil winding machine had to be worked out by the scientist before the principle could be successfully utilized. Perfected machines of this kind are now being installed in America at the plant of the Weston Electrical Instrument Corp., Newark, N. J. Studies to provide a background for using the principle in instruments specifically designed to meet American requirements are now being carried on by the Weston organization.

New Acetylene Cylinder Manifold

A new wall type acetylene cylinder manifold, the "Oxweld Type M-8," has been announced by The Linde Air Products Co., 30 East 42nd St., New York. It is available in a 10-cylinder unit to which extensions in units of 5 cylinders or 10 cylinders can be made. The new manifold has been accepted by Underwriters' Laboratories for listing under their Reexamination Service.

The Oxweld Type M-8 acetylene manifold consists of two high-pressure header units. These feed into a central regulation system which delivers acetylene to the distribution piping system at pressures up to 15 lb. per sq. in. The header unit assemblies are composed of heavy seamless steel tubing with forged steel union connections having stainless steel seat inserts. Header valves for cylinder connections are of heavy construction and are threaded directly into the steel tubing header. The extreme ends of the header assembly are closed with forged steel caps. Connections from the header valves to the cylinder valves are made with flexible leads. Each is coiled to provide sufficient flexibility, fitted with an approved Prest-O-Lite flash arrester and is provided with a ball check valve in the header end. This guards against the possibility of acetylene from the header being driven back into an exhausted cylinder.

The two high-pressure header assemblies are connected by forged steel unions to a central system of 6 valves and 2 regulators for controlling the operation of the manifold. These regulators have been designed for heavy-duty service, and will handle a wide variation in load with less effect on the delivery pressure than would ordinarily be expected.

The pressure in each header is indicated on Oxweld high-pressure acetylene gauges located on the headers near the union connections to the regulator assembly. A low-pressure gauge attached to the outlet of the hydraulic back-pressure valve indicates the delivery pressure to the shop piping system. The acetylene manifold should be installed in accordance with the regulations of the National Board of Fire Underwriters for the installation and operation of gas systems for welding and cutting.

A New Brass Die Casting Alloy

The Doehler Die Casting Co., 386 Forest Ave., New York, announces a new brass die casting alloy under the trade name "Doler-Brass," containing copper, zinc and silicon. It is especially adapted to the die casting process and results in a fine finish when cast. It has unusual physical properties as follows: Tensile strength, 65,000 to 75,000 lb. sq. in.; yield point, 30,000 to 40,000 lb. sq. in.; elongation, 20 to 25% in 2 in.; reduction of area, 20 to 25%; Brinell hardness, 110 to 120 (500 kg.); impact strength, 30 to 36 ft. lb.; color, light yellow.

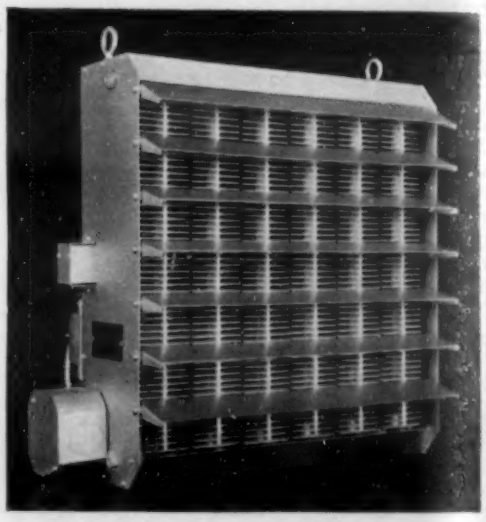
The addition of "Doler-Brass" to its other trade-marked alloys "Brastil" and "Doler-Niklbrass," previously announced, bring a wide range of copper base alloys in die cast form to the designing engineer.

Electromode Unit Heater

"Electromode" electric unit heaters are being marketed nationally by the Electric Air Heater Co., division of American Foundry Equipment Company, Mishawaka, Ind. These heaters are sold in three standard types, one of which is illustrated, and are available in a variety of heat producing sizes.

The outstanding feature of the Electromode Heater is the exclusive cast-in electric heating unit. It consists of a helicoil sheath wire type of resistance heater element cast integral with an aluminum fin type of grid. The units are made in various sizes in both the rectangular and round shapes, the size and shape depending upon the model and the size of the heater in which used.

These fin type grids, it is said, give the greatest dissipation of heat in a given area, making possible compact units of high B.t.u. output. The heat transformed from electrical energy is quickly conducted through the fin area of the heating unit and is carried off by forced air circulation. The large convection surface of the units enables



operation at low temperature affording entire safety which heretofore has been the drawback of electric heating devices. These heating units operate with a maximum temperature of 250 deg. F. There are no dangerous hot wires or glow units.

The three standard types are: The portable type which can be carried from room to room and plugged into a wall socket; the built-in wall type Electromode, designed to be built into homes or other establishments; the industrial type unit for suspension from ceiling wall brackets, etc., for semi-portability around industrial plants.

New Ferroalloys and Welding Machine

New developments in oxy-acetylene welding and cutting, hard-facing, ferroalloys and alloy steels were displayed and demonstrated by three units of Union Carbide & Carbon Corp. at the National Metal Exposition in Chicago.

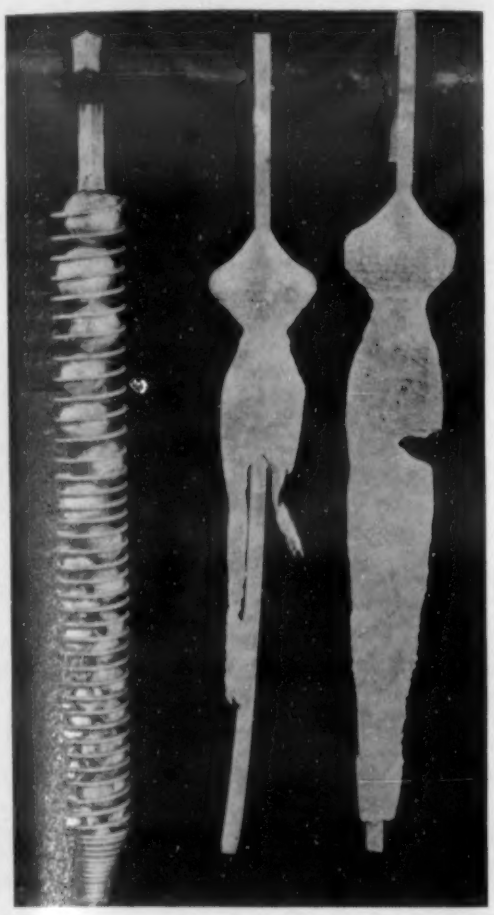
Of many actual live demonstrations presented by The Linde Air Products Co., was the operation of the new "Oxweld Shape-Cutting Machine," Type CM-12. This remarkable machine features dual control, and incorporates modern mechanism of new design for highly efficient operation and extreme precision.

The exhibits of Electro Metallurgical Company featured the use of two new ferroalloys, ferrocolumbium and high nitrogen ferrochrome.

Ball Anodes for Copper, Brass and Zinc Plating

The Udylite Co., Detroit, manufacturers of polishing and plating equipment and supplies, announces that ball-type anodes are now available for copper, brass and zinc plating. Advantages claimed for the ball anode are as follows:

(1) **Maintains constant anode area**—thus keeping metal content of the plating solution at the desired level and eliminating expensive salt additions to replenish metal content; (2)



Visual comparison between ball anodes and the common slabs. At left, is the container filled with balls. As the latter corrode, they descend in the container and a fresh anode is added at the top. At right, is shown corrosion typical of slab anodes. Their area decreases as they corrode, disturbing the metal content of the bath. There is also a considerable scrap loss with this type of anode.

Scrap losses are eliminated. As the ball anodes corrode, their diameter diminishes and they descend in the container. Even the smallest scraps are completely used up; (3) **Convenient method of anoding**—Containers are filled from the top and even in large installations, this operation takes but a few minutes of a man's time. There are no heavy anodes to be handled; (4) **Less investment** in anodes required to equip plating tank. With ball anodes, more area is exposed. Consequently, it takes fewer pounds of anode metal to obtain a given anode area.

The Udylite company furnishes, in any quantity, pure electrolytic, copper balls, zinc ball anodes in either pure or alloy zinc and standard 80-20 brass ball anodes (80% Cu-20% Zn).

Largest Gas-Electric Tiering Machine

In the new sheet plant of the Youngstown Sheet and Tube Company at Youngstown, Ohio, there has been installed a gas-electric tiering machine that is the largest of its kind. Used for handling sheets to and from shears, rolls, scales, warehouses, etc., the machine is capable of handling sheets of any width from 1 to 6 ft. and of any desired length. Built by the Ross Carrier Co. of Benton Harbor, Mich., it incorporates General Electric motors and control.

The new machine, self-propelled on rubber-tired wheels, carries its own gas-electric power plant. In operation it merely runs over, or straddles, the load; and then the operator applies power to a mechanism that engages the load and lifts it. The load may then be transported to any point in the plant. Material may be hoisted to a height of six feet, so that loads may be tiered or double-decked.

Loads up to 15 tons can be handled at a hoisting speed of 6 ft. per min. The pick-up equipment is so arranged that the operator can adjust the width of the main lifting members to the load width and can shift the load from side to side for accurate spotting while tiering.

Machines of this type have shown exceptional savings in the steel industry. All operations are controlled from the driver's seat and, as a result, handling operations are greatly simplified. Furthermore, the machine is not restricted to any particular area, but can travel between bays and buildings.

A New Inhibitor

A new inhibitor for which distinctive advantages are claimed is announced by E. F. Houghton & Co., Philadelphia, the product being known as "Ferritrol No. 100."

Based on the accepted theory that it is not necessary to attack metal to remove scale, Ferritrol No. 100 represents the outcome of years of investigations and research. The efficiency of an inhibitor, according to statement from the Houghton research staff, depends on the nature of the film, its ability to plate on in the presence of much disturbance, its thickness after deposition, its lack of porosity, its dielectric strength, its ability to withstand heat without breakdown and last but not least its eventual solubility in the rinse.

Working along these lines the company's research department has developed an inhibitor with a strength claimed to surpass any heretofore offered. It is heat resistant far above pickling temperatures and will not break down at 220 deg. F. Its use prevents pitting or loss of steel and leaves a chemically clean surface.

Another advantage is the ability to use this inhibitor together with copper sulphate for coprodizing. Parts are pickled in the usual manner in tanks containing a 5 per cent solution of sulphuric acid and the necessary amount of Ferritrol No. 100. To the contents of this tank is added a small quantity of copper sulphate. As the scale is pickled off, the copper deposits on the steel, which will prevent rusting. It is stated that no other inhibitor allows the copper to plate on to the steel in the pickling room.

New Stainless Steel Welding Rod

A new stainless welding rod for welding cr-ni steels of the 18-8 type has been announced by The Linde Air Products Co., 30 East 42nd St., New York. Known as "Oxweld No. 28 Columbium-Treated 18-8 Welding Rod" (patent applied for), this is a most important addition to the Oxweld line of welding rods. It simplifies the fabrication of products from 18-8 stainless steel and greatly improves the corrosion-resistance of the fabricated joint areas.

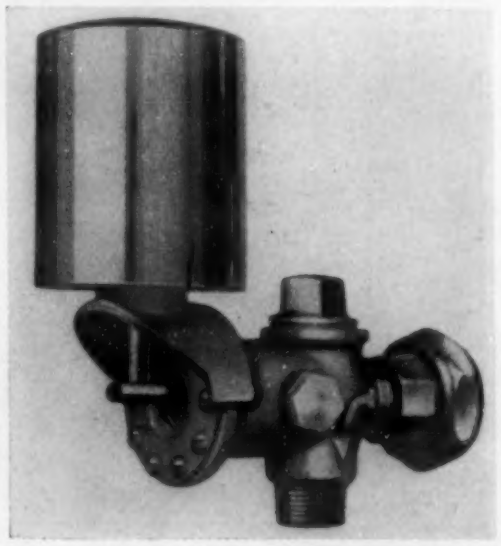
The outstanding and unique feature of the new "Oxweld" rod which makes it superior for this work is the inclusion of a definite quantity of the element columbium. Because of this feature, products fabricated from "treated" or "stabilized" 18-8 steel by welding with this rod have full corrosion resistance and heat resistance in the as-welded condition. No heat-treatment after welding is necessary.

Because of resulting economies and improved welds, the use of this rod greatly extends the possibilities of oxy- acetylene welding in the fabrication of 18-8 equipment to be used under corrosive or oxidizing conditions. This is particularly true with fabricated articles subjected to high temperatures. The use of "Oxweld No. 28" rod requires no special technique other than that usually employed in welding stainless steel.

New Lammert Control Valves

The control or automatic shut-off valve illustrated, embodies a number of new features and refinements which include: Few parts; extremely compact; large capacity; simple design and construction; interchangeable elements for air control, steam-pressure control, water-pressure control or electrical control. Any one of these controls is connected by merely screwing it into the standard valve-body mechanism. Valves can be adapted to automatic operation, to remote control, or to automatic operation plus an interlock with a manual-reset device.

The valve itself has but two moving parts and is held firmly in position, when closed, by a cadmium-plated spring. The valve needle and seat are of stainless steel, insuring



perfect seating, quick action, trouble-free service and long life. All other parts are also of non-corrosive metals. Unusual ease of dis-assembly is a feature. Any part of the valve can be removed in a few seconds, without detaching the valve from the line.

The operating lever, which is actuated by the control device, transmits the force to lift the needle valve. The interlock and manual-reset device is a latch-and-weight arrangement which holds the valve in position after it has closed, until the weight has been reset manually. The air-control mechanism is of the piston type, and a pressure of 3 to 50 lb. may be used. All parts of the air-control are free-moving, free from binding or sticking. Since solenoid-operated valves and springs gum or "coke up" in some kinds of liquids, due to the heat generated by the solenoid, the electrical control of the Lammert valve is through an electro magnet, and the spring which closes the valve is entirely separated from the fluid.

These valves, with the various types of interchangeable controls, are applicable to many uses on manufactured products or equipment as well as in the power or supply lines of present power plants. With any of the type of control mentioned, these valves will handle the heaviest and most viscous oil without sticking. They are made by Lammert & Mann Co., 258 N. Wood St., Chicago, in standard sizes from ⅜ in. up.

Four New Developments in Optics

At the National Metal Congress, Chicago, Sept. 30 to Oct. 4, Bausch & Lomb Optical Co., Rochester, N. Y., will introduce four new developments in the field of optics in which the metal industries will be interested. These are a new Ortho-Stereo Camera and Stereoscope; a new Electro-Platers Microscope; a new Grain Size Measuring Eyepiece, particularly designed for Bausch & Lomb Metalloscope, or similar equipment; and a new Ampliplan Eyepiece producing exceptional flatness of field for use in photomicrography.

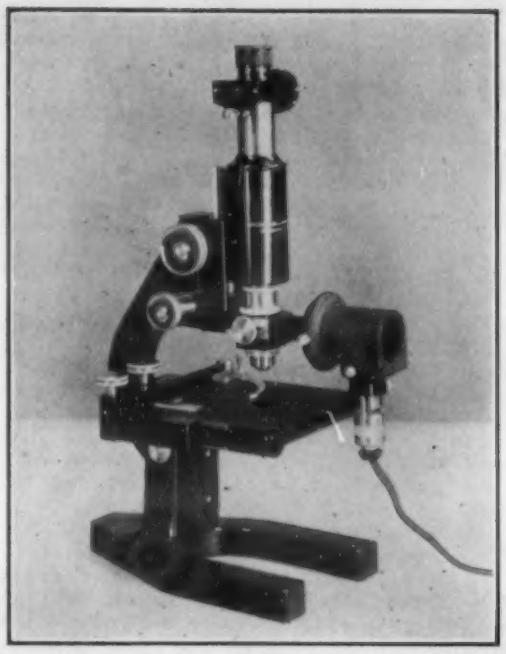
The Ortho-Stereo Camera employs the principles of stereoscopy in photography, rendering an object in three dimensional perspective, and supplying the eye with an impression that the ordinary flat photograph cannot achieve.

The Ortho-Stereo Camera will supply pictures which may be observed under the following magnifications; 1, 1.7, 3.75, 6.6, 11, and 24 diameters. Change from magnification to magnification requires only the substitution of one photographic objective for another, each marked with the magnification at which it will work.

The new Electro-Platers Microscope is the latest instrument for the rapid and accurate measurement of plate depth. Tests have shown its great usefulness in determining minimum thickness measurements. It consists of a monocular microscope stand equipped with coarse and fine adjustments, an achromatic objective, a Filar micrometer eyepiece, a vertical illuminating unit, and a mechanical stage for correctly locating the specimen in the field of the optical system. The Filar micrometer eyepiece has a movable hair actuated by a micrometer screw with a drum graduated in 100 divisions.

The Bausch & Lomb grain size measuring eyepiece follows a suggestion of Dr. Marcus Grossman for a quick, easy and accurate determination of grain size according to ASTM numerical index, generally employed by leading makers and fabricators of iron and steel. The old method was to take photomicrographs and compare them with a series of standard photomicrographs of known grain count. The new grain size measuring eyepiece is a direct reading. This new measuring eyepiece can be employed equally well visually and in photomicrography. It is easy for the metallurgist to take a direct reading rather than make a mental comparison between the magnified image and a series of standard photomicrographs or charts.

The new Ampliplan Eyepiece has been designed to give an unusually flat field. The curvature of field common to microscope objectives, due to



the attempt to secure sharp images at the center of the field, has been compensated for in this negative lens combination, which is intended only for projection or photomicrography. A special adapter must be substituted for that customarily supplied with microscopes. The new Ampliplans are engraved Low, Medium and High, and should be used with the 16mm, 8mm and all high power dry and oil immersion objectives.

New Line of Humidified Buffs

The Udylite Co., Detroit, manufacturers of plating equipment and supplies, has recently introduced a new line of buffing and polishing wheels. The distinctive feature is the special pretreatment given to the cloth before making it up into buff sections. This pretreatment is the Udylite humidifying process which introduces proper moisture content into the fibres of the cloth to give it maximum tensile strength and wear resisting qualities.

It is a scientific fact that cloth, when allowed to dry out or become deficient in moisture content, is weakened and is likely to resist wear as well as cloth in perfect condition. To make certain that Udylite buffs are properly conditioned to provide maximum service and longer life, every piece of cloth entering into their construction is given the humidifying treatment. To further ensure the arrival of properly conditioned buffs at the customer's plant, the buffs are sealed in moisture proof paper. It is claimed that Udylite buffs lower buffing costs through better performance and longer life because of the new humidifying process.

Udylite Humidified buffs are available in all sizes, types and styles of sewing, made to specifications. The Udylite company also furnishes a complete line of polishing wheels.

Automatic Anodizing Treatment for Pistons

Completely automatic operation and close control are features of the latest installation for "anodizing" alloy pistons. Located at the Buick Motor Car Co's plant in Flint, Mich., the installation is completely conveyorized. The process gives the pistons a hard, long wearing coating, integral with the metal.

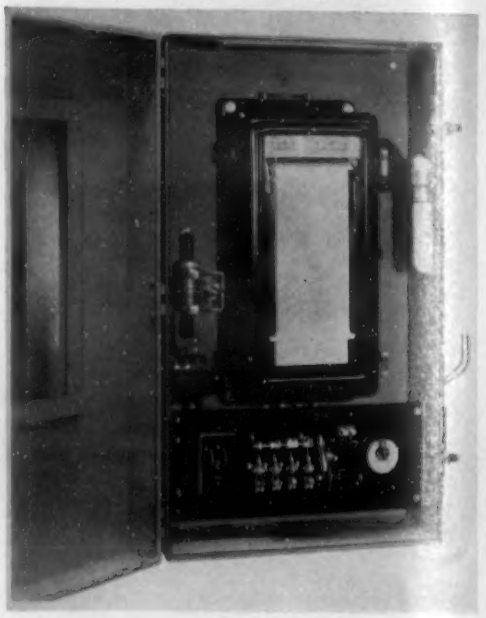
It is, in effect, a "de-plating" operation. Instead of depositing material on the piston, the electric current in the bath is reversed to change the surface metal of the piston to a hard oxide, thereby greatly increasing the life of alloy pistons.

Steel Temperature Recorder

The new "Velarmeter," just announced by the Bacharach Industrial Instrument Co., is claimed by the manufacturer to provide means for making close temperature measurements in the processing of steel. The Velarmeter will measure the temperature of the steel being rolled and also will record the temperature graphically on a chart moved according to time. In this manner, the mill superintendent is provided with a production as well as a temperature record of each piece of steel rolled.

The instrument is entirely automatic. The temperature measuring element is mounted permanently on or near the rolling mill and is connected to the recorder by a pair of wires. The recorder may be located a distance from the measuring element, at a convenient place.

The measuring element is a tiny thermocouple which receives heat from the steel through a lens. The current generated by the thermocouple is measured by a high speed recording galvanometer. One dot is made on the chart showing the temperature of each piece of steel. The use of a thermocouple for temperature



measurement and of a simple galvanometer for recording is claimed by the manufacturer to assure absolutely constant accuracy and minimum maintenance.

A Fast Machining, Case Hardening Steel

"Speed Case," offered by the Monarch Steel Corp., Indianapolis, is by far the fastest machining open-hearth case hardening steel available, it is claimed. Based upon Bessemer screw stock machinability rate of 100 per cent speed case or X1525 is more than 115 per cent. In machines at 190 surface ft. per min. as against 150 surface ft. per min. for SAE 1112 or 200 surface ft. per min. for resulphurized No. 2 Bessemer steel in comparison with X1314 in. machines approximately 25 per cent faster or 190 surface ft. per min. as against approximately 140 for X1314. In addition to the free machining of Speed Case, is the important point that the tool leaves the surface very smooth as this steel does not tear.

At 1650 to 1700 deg. F. Speed Case will produce a 1/16-in. case in 6½ hr. as against 8 to 10 hr. for X1314 or X1020. With the above treatment it will give a surface hardness of 66 Rockwell C scale with a practically perfect case structure and uniformity of case equal or superior to any steel known. It will carburize without any appreciable distortion or warpage.

Summing up, it can easily be seen that Speed Case will save money regardless of the steel being used.

"Lithoform" Makes Paint Stick to Galvanized Iron

With the development of "Lithoform" by the American Chemical Paint Co., Ambler, Pa., the old problem of making paint stick to galvanized iron and "Galvaneal" has finally been solved. When surfaces are treated with this new chemical they will "take" paint perfectly. The coating provided by "Lithoform" will not wash off, it will not chip, it will not corrode in the weather, and it is not affected by baking temperatures.

"Lithoform" is applied by brushing it on, or by spraying. The surface is first cleaned and then lightly scoured with fine steel wool. Following the "Lithorizing" treatment, the surface is washed and dried and is ready for painting. "Lithorized" surfaces will not react with the atmosphere, so they do not have to be painted immediately.

Research found that the reason paint would not adhere to such materials was because the zinc oxides and carbonates formed by reaction with the atmosphere combined with the oil in paint to form an insoluble, inelastic zinc soap. It was this inelastic soap layer between the metal and the pigment that cracked and caused the paint to peel. "Lithoform," by purely chemical action, forms an impervious stone-like coating on the metal, and prevents the formation of zinc soaps. It is designed to cover 1000 sq. ft. of surface per gallon. It is available in quart and gallon bottles, and 5 and 12 gal. carboys.

Van Norman Exhibits Four New Millers

Four new milling machines were exhibited in operation at the Machine Tool Show in Cleveland, Sept. 11 to 21, by the Van Norman Machine Tool Co., Springfield, Mass. All four of the new machines employ the swiveling cutterhead, which has always been typical of Van Norman millers. Major changes, however, have been made in the design of the machines to fit them for high-speed operation.

The new line includes what the manufacturer describes as the lowest-priced Van Norman miller ever built—the No. 6 machine, a compact miller with hand feeds throughout, particularly suitable for work on small tools and dies, and for experimental shops. Also included is the fast No. 32 machine, with greater range than any which this company has ever made, built for handling a wide range of work, not only in the tool room, but also in short-run production milling.

The machines handle many operations on a piece without a change of set-up. All the machines are capable of milling vertical, horizontal, and angular spaces throughout the entire run of the table without complicated blocking, and with the use of standard right-angle cutters. Attachments adapt the machines for boring, slotting, high-speed routing, profiling, and, on the two larger models, drilling, and cutting spirals—all without a change in set-up.

Light Weight Insulating Brick

"Therm-O-Flake" brick is claimed the lightest weight insulating brick on the market. The 9 x 4½ x 2½ in. straight weighs only 18 ounces. These brick have an excellent thermal conductivity efficiency and can be used for temperatures up to 2000 deg. F. They have the peculiar property of compacting under uniform pressure, without disintegration, which allows for use in "cushioning" steel furnace buckstays and furnace plating, where expansion stresses are set up by expanding brickwork, and which, in ordinary construction, would cause deformation of the metal bindings. Therm-O-Flake brick can be made up in any size or shape.

NOW ARMSTRONG

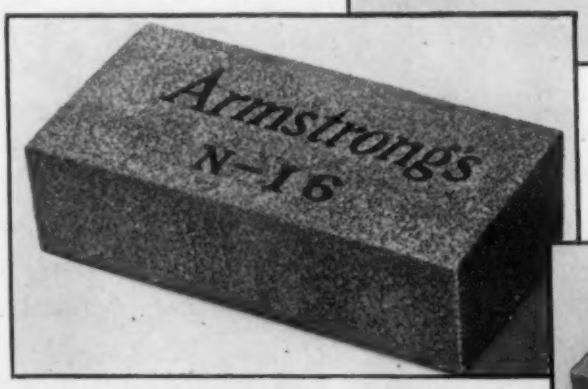
rounds out its line with

NEW N-20 INSULATING BRICK

These five high temperature products offer brick for a complete range of temperatures and uses.

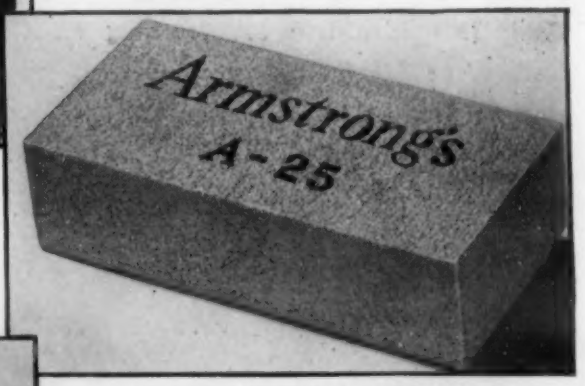
N-20 INSULATING BRICK

For Use Behind the Refractory—Temperature limit 2000° F.; Crushing Strength Cold, in excess of 225 lbs. per sq. in.; weight, 2.1 lbs.



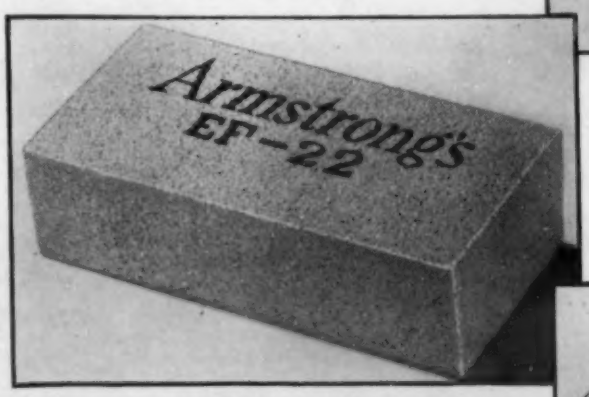
N-16 INSULATING BRICK
(Formerly Nonpareil)

For Use Behind the Refractory—Temperature limit 1600° F.; Crushing Strength Cold, 200 lbs. per sq. in.; Crushing Strength at 1600° F., 218 lbs. per sq. in.; Weight 1.8 lbs.



A-25 INSULATING BRICK
(Formerly Armstrong's)

For Use Behind the Refractory—Temperature limit 2500° F.; Crushing Strength Cold, 225 lbs. per sq. in.; Crushing Strength at 2100° F., 91 lbs. per sq. in.; Weight 2.2 lbs.



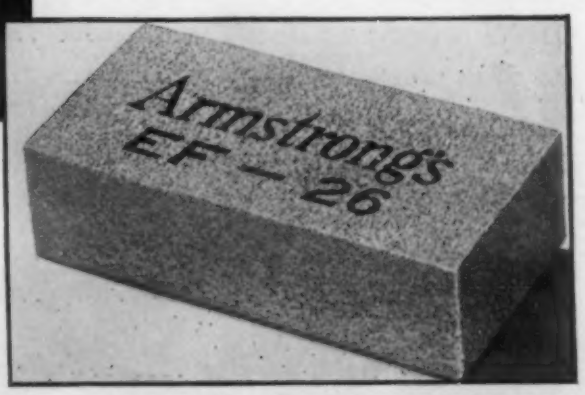
EF-22 INSULATING FIRE BRICK

For Use Directly Exposed—Temperature limit 2200° F.; Crushing Strength Cold, 340 lbs. per sq. in.; Crushing Strength at 2100° F., 480 lbs. per sq. in.; Weight 2.75 lbs.

~ ~ ~

All five Armstrong's Brick are available in all standard fire brick shapes and sizes, also special shapes, each brick accurately sized to 4/1000 of an inch.

For additional data and samples, write Armstrong Cork Products Company, Building Materials Division 982 Concord Street, Lancaster, Penna.



EF-26 INSULATING FIRE BRICK

For Use Directly Exposed—Temperature limit 2600° F.; Crushing Strength Cold, 450 lbs. per sq. in.; Crushing Strength at 2500° F., 125 lbs. per sq. in.; Weight 2.75 lbs.

Armstrong's

HIGH TEMPERATURE INSULATION

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